The National Cooperative Highway Research Program (NCHRP) is supported on a continuing basis by funds from participating member states of the American Association of State Highway and Transportation Officials (AASHTO), with the full cooperation and support of the Federal Highway Administration, U.S. Department of Transportation. The NCHRP is administered by the Transportation Research Board (TRB) of the National Academies of Sciences, Engineering, and Medicine. The NCHRP is an applied contract research program that provides practical and timely solutions to problems facing highway and transportation practitioners and administrators.

Each year, AASHTO refers a research program to the TRB consisting of high-priority problems for which solutions are required by the states. The NCHRP program for FY 2024 is expected to include 7 continuations and 63 new projects.

This announcement contains preliminary descriptions of only those new projects expected to be advertised for competitive proposals, and for which nominations for qualified professionals to serve on research oversight panels are sought. Nominations will be accepted on the TRB website through MyTRB at https://volunteer.mytrb.org/Panel/AvailableProjects.

Before nominating yourself to serve as a panel member, please review our Conflict of Interest policy: https://www.trb.org/NCHRP/COI-CRP.aspx. Please be advised that if you are selected to serve on a panel and we receive a proposal for that project that presents a conflict of interest for you, we will reject the proposal. This also applies to liaisons.

Detailed Requests for Proposals (RFPs) for these new projects will be developed beginning in August 2023. Please note that NCHRP requests for proposals (RFPs) are available only on the TRB website. Those who have an interest in receiving RFPs can register on the website http://trb.org/nchrp. Upon registration, you will receive an e-mail notification of every RFP posting and an e-mail notification of new anticipated projects in future years.

Because NCHRP projects seek practical remedies for operational problems, proposals should demonstrate strong capability gained through extensive successful experiences in the relevant problem area. Consequently, any agency interested in submitting a proposal should first make a thorough self-appraisal to determine whether it possesses the capability and experience necessary to ensure successful completion of the project. The specifications for preparing proposals are set forth in the brochure titled Information and Instructions for Preparing Proposals. Proposals will be rejected if they are not prepared in strict conformance with the section titled “Instructions for Preparing and Submitting Proposals.” The brochure is available on the Internet at the website referenced above.

Address inquiries to:
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Transportation Research Board of the National Academies of Sciences, Engineering and Medicine
wdekelbab@nas.edu
IMPORTANT NOTICE

Potential proposers should understand clearly that the research program described herein is tentative. The final program will depend on the level of funding available from the Federal-aid apportionments for FY 2024. Meanwhile, to ensure that research contracts can be executed as soon as possible after the beginning of the fiscal year, the NCHRP is proceeding with the customary sequence of events through the point of research agency selection for all projects. The first round of detailed Requests for Proposals will be available starting in September 2023; proposals will be due beginning in October 2023, and research agency selections will be made beginning in December 2023. This places the risk of incurring proposal costs at the election of the research agencies. Beyond the point of selecting agencies, all activity relative to the FY 2024 program will cease until the funding authorization is known. These circumstances of uncertainty are beyond NCHRP control and are covered here so that potential proposers will be aware of the risk inherent in electing to propose on tentative projects.
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The pavement industry has changed significantly in the last couple of decades. Digital technology is now capable of generating continuous streams of data for multiple metrics (longitudinal and transverse profile, cracking, texture, etc.) that can assist in assessing the functional performance of a pavement. More recently, traffic speed deflection devices (TSDD) have been developed to collect pavement structural response continuously at highway speeds.

Both functional and structural condition data are needed to make better informed and more cost-effective treatment decisions when rehabilitating existing pavement structures. A series of previously developed indices (such as international roughness index) are widely used to characterize pavement performance characteristics based on continuous pavement surface measurements. However, similar current structural metrics/indices were developed based on the measurements and technologies developed several decades ago, some from noncontinuous data, and require periodic lane closures during data collection. The loading characteristics and load type generated from TSDDs are different from these traditional methods (e.g., falling weight deflectometer [FWD] devices) and are more representative of actual moving heavily loaded vehicles. Therefore, the existing structural metrics/indices do not fully represent the structural characteristics that can be measured by the TSDDs. To take full advantage of the collected TSDD data, effective structural metrics/indices are needed to characterize pavement structural conditions directly based on the TSDD measurements. This will make it possible to use TSDD measurements in mechanistic-empirical pavement analysis methods rather than just empirical or qualitative methods (e.g., identifying relatively strong and weak sections.)

As technology continues to rapidly advance, these new structural metrics/indices will help quantify when and where pavement structural deterioration is occurring before it becomes evident as surface distresses. This will allow for better planning and allocation of funding resources. Such structural metrics/indices should ultimately be used in pavement management, pavement design support, and construction quality control.

The objective of the proposed research is to develop structural metrics/indices to characterize pavement structural deflections based on continuous structural response measurements, as measured by the TSDD, for pavement management and pavement design applications. To achieve this objective, this research should include the following tasks.

1. Conduct a literature review to identify structural metrics/indices that might merit consideration and identify benefits and potential limitations of each. Based on the literature review, document why existing metrics (based on previous technology) do not apply.

2. Identify or develop methodologies and guidance for effectively generating the structural metrics/indices (identify critical structural items; develop metrics/indices based on continuous deflection measurements; and evaluate the new metrics/indices on different pavement types having different structural condition using both modeling and available field data). Almost 10,000 miles of data have been collected each year, as part of Pooled Fund Study TPF-5(385), “Pavement Structural Evaluation with Traffic Speed Deflection Devices” over the last several years.
3. Provide recommendations for implementation and application of the metrics/indices proposed (identify metrics/indices thresholds as a function of key indicators, such as annual equivalent single axle load (ESALs) or annual average daily truck traffic (AADTT), pavement type, etc., that provide unique performance distinctions, demonstrate value through application for pavement management, and identify future research needs.)

Project 03-150
**Update to Procedure for Determining Work Zone Speed Limits**

Research Field: Traffic  
Source: Delaware Department of Transportation  
Allocation: $600,000  
NCHRP Staff: Ann Hartell

*NCHRP Research Results Digest 192: Procedure for Determining Work Zone Speed Limits*, remains the definitive research regarding work zone speed limits. The digest, which resulted in the guidance in the current edition of the *Manual on Uniform Traffic Control Devices* (MUTCD), concluded:

- Mean speeds were approximately 5-mph lower within work zones with no speed limit reduction and that work zone speed limit reductions should be avoided, particularly where work activities are in shoulders or when no work activities are underway;
- A 10-mph reduction below the normal speed limit when work takes place on the traveled way or personnel are working in an unprotected position within 10 feet of the traveled way; and
- Work zone speed limit reductions greater than 10-mph should be avoided.

However, the research was completed in 1993 and is becoming increasingly dated. Notably, the repeal of the National Maximum Speed Limit (NMSL) during the study period, potentially influenced the conclusions and the recommended procedure. *NCHRP Research Results Digest 192* notes that the NMSL produced poor compliance with the 55-mph speed limit and recognized that speed limit reduction also resulted in poor compliance while the level of speed limit compliance increased if the work zone speed limit was unchanged. These observations and conclusions should be verified or updated on present-day sites without the influence of the NMSL. Further, work zone technologies, policies, and practices have changed in the 29 years since the original research was completed. Examples include use of ITS technologies in work zones, emphasis on providing positive protection between road users and workers (23 CFR Part 630, Subpart K), law enforcement practices including automated enforcement, and others.

The objective of this research is to update the procedure for determining work zone speed limits by:

1. Collecting and analyzing work zone speed and crash data to test the conclusions from *NCHRP Research Results Digest 192* to determine if present-day data verifies the conclusions or whether different conclusions are drawn from new data; and
2. Developing an updated procedure for determining work zone speed limits to be used for construction and maintenance operations and accommodate, to the maximum extent possible, the interests of motorists, workers, pedestrians, bicyclists, and transit operators and users.

Project 03-151

Research Field: Traffic  
Source: Michigan Department of Transportation  
Allocation: $500,000  
NCHRP Staff: Zuxuan Deng
Currently, limited technical information and resources exist to assist agencies with assessing the capabilities and evolving needs for their TMS data subsystems. In addition, there are limited resources to support agencies integrating the needs and requirements of their data subsystems into the decisions that occur in various planning and programming processes throughout the life cycle of a TMS (e.g., how to plan, design, or procure needed data storage and management capabilities). Agencies also face challenges with systematically managing data as part of their operating a TMS. There are also limited resources for agencies to use to assist with managing data (e.g., archiving, use, configuration, and monitoring use), issues to consider with receiving and sharing or using data with third party sources or within an agency (e.g., licenses, proprietary, and sensitive information).

The objectives of this research are to develop two technical reports. The first report will review and compile information from available resources, offer insights, and synthesize current practices. This information will support agencies (1) determining the appropriate factors to consider with assessing the capabilities of their data subsystems, identifying needed enhancements, and options to consider with making any improvements, and (2) developing requirements and identifying other issues (e.g., resources, buy, lease, security) when considering or selecting methods to acquire and implement data subsystems and resources to improve current and future TMSs to store and manage data.

The second technical report will review and compile current practices with managing data and assist with applying the techniques appropriate to meet the needs and requirements unique to TMSs (e.g., real-time data collection, multiple systems in different locations, and virtual operation). This report will include identifying issues with developing or updating data management policies, procedures, plans, resource needs, and practices in support of meeting the needs and requirements unique to TMSs. This report will address the needs agencies have identified associated with developing or updating policies, procedures, practices, and resources used (e.g., tools) to facilitate their TMSs collecting, using, or sharing data within their agency, with other systems, or the public.

Project 07-35
Improving Data on Fatalities and Injuries Involving Active Transportation, Non-Motorized and Vulnerable Road Users, Including Crashes Not Involving Motor Vehicles; and Refining Active Transportation, Non-Motorized and Vulnerable Road User Crash Types.

Research Field: Traffic
Source: CalSTA
Allocation: $1,250,000
NCHRP Staff: Richard Retting

Although crash data is the primary source for safety analysis, this data has many limitations, including inconsistencies in reporting, inaccurate or incomplete coding of crashes, underreporting, and low frequency, especially for active transportation. Also, crash typing, used to describe events and movements prior to a crash, are typically available to characterize motor vehicle crashes, however, for pedestrian- and bicycle-involved crashes, these details are not available or must be constructed using multiple variables. Crash typing is necessary for improved crash analysis and planning for safer networks.

Improving pedestrian and bicyclist injury and fatality data (crash severity, time, location, including crashes not involving motor vehicles), adopting consistent typing methods at the national and local levels, improving data storage, sharing and accessibility, and integrating police and hospital crash data, would help practitioners understand risk factors and potential interventions. Further, it is important to understand the reasons for underreporting, and the related implications. The research should also address the need to better understand the potential benefits of integrating police and medical records, including the potential for tracking of crash victims' mid to long range outcomes.

The objectives of this research project are:
• Identify and document current crash data shortcomings related to inconsistencies and inaccuracies in reporting of active transportation crashes;
• Review the existing methods and develop recommended methods to categorize the types of motorist-bicyclist, motorist-pedestrian and non-motorist-bicyclist/pedestrian collisions;
• Collect and document best practices to improve the timeliness, accuracy, completeness, uniformity, integration and accessibility of crash data (fatal and non-fatal);
• Develop recommendations to achieve these goals, including strategies to uniformly specify crash location, time, severity and contributing factors;
• Develop recommended methods to improve and standardize crash typing for bicycle and pedestrian crashes, to capture both the circumstances related to the crash as well as the types of non-motorized and vulnerable road users involved;
• Collect information on non-motorist injury outcomes based on collisions with vehicle types;
• Develop training and incentives for law enforcement to capture information completely and accurately regarding non-motorist vehicle types, such as e-scooters and e-bicycles;
• Examine adoption and use of the Model Minimum Uniform Crash Criteria (NHTSA Manual) – and recommend measures to amend or expand their use;
• Develop recommendations for understanding non-motorist victim demographics and characteristics to inform efforts to improve equity outcomes, and to inform public health analysis, prevention and related interventions;
• Identify and summarize the top crash types for motorist-bicyclist, motorist-pedestrian and non-motorist-bicyclist/pedestrian collisions;
• Develop recommendations to improve the consistency of regional, statewide and national active transportation data practices; and
• Collect and document best practices to track long-term safety outcomes and develop additional recommendations to achieve these goals.

Improving pedestrian and bicyclist injury and fatality data (crash severity, time, location, including crashes not involving motor vehicles), adopting consistent typing methods at the national and local levels, improving data storage, sharing and accessibility, and integrating police and hospital crash data, would help practitioners understand risk factors and potential interventions.

Direction from the AASHTO Committee on Research & Innovation: Two different panels. Look at the scope in detail. 1) Data collection side… 2) What to do with it. Staff to make a recommendation for splitting of the budget.

Project 07-36
Self-Explaining Roads in the Safe System: Addressing Target Speeds within Context

Research Field: Traffic
Source: Washington State Department of Transportation
Allocation: $700,000
NCHRP Staff: Roberto Barcena

The self-explaining roads (SERs) concept can be effective in speed management resulting in fewer fatal and serious injury crashes. Successful SERs include features that clearly indicate the type of road and act implicitly to elicit appropriate speeds through design and operational characteristics. SER has a long theoretical history with a handful of individual and project-level implementation documents along with several research works exploring the impact of specific features on driver speed profiles proving that these formulas are possible and can be effective in corridor evaluation and planning.
As transportation agencies continue their implementation of the Safe System Approach, greater emphasis will be placed on the proactive need to reduce road user errors and create roads that can meet the following requirements: (1) effectively manage and maintain speeds within the context and classification of the road to minimize injuries; (2) provide road users with critical information to make the road understandable and consistent with driving speed expectations; and (3) increase road users’ attention to needed actions, road changes, and presence of other road users to reduce driver errors that lead to crashes. This research is intended to bridge the gap between the SER concept and its implementation in different functional classes and context within the road system.

The objective of this research is to develop a guidance document for applying the SER concept to roadway design and operations. The proposed work will evaluate roadway operating characteristics of geographic areas (a city or regional sub-area) to compare the features of roads with good compatibility between posted and operational speed, strong multimodal use, and low crash frequency and injury severity outcomes with roads that do not to better understand approaches to achieve target speeds.

**Project 08-175**

*Understanding Travel Behavior Impacts of Transportation Systems Management and Operations (TSMO)*

**Research Field:** Transportation Planning  
**Source:** Texas DOT  
**Allocation:** $500,000  
**NCHRP Staff:** Zuxuan Deng

TSMO strategies and approaches play an increasing role in meeting transportation agencies’ strategic goals of improved equity, mobility, reliability, and safety. Many evaluations of the effectiveness of TSMO deployments have been performed over the last few decades, but most have focused on the system performance outcomes, namely the impacts on performance metrics such as travel speed, travel time, delay reduction, and crash rates. The impacts of TSMO strategies on critical impacts in the traveler behavior realm, such as mode choice, departure time, route choice, and other traveler decisions are not well known. In addition, the impact of traveler behavior (due to TSMO deployments) on the overall transportation network performance is not well established. By better understanding how deployed TSMO strategies affect the tactical and strategic behavior of travelers, more effective combinations of TSMO approaches can be designed to help agencies meet their goals.

This project will evaluate the impacts of TSMO deployment on traveler behavior and corresponding network performance using data from active TSMO deployments. Specifically, traveler behavior in this context refers to how travelers plan their journey and in-journey decisions made based on the choice sets available to them. There are typically five (5) stages in an immediate trip chain: destination choice, time of day choice, mode choice, route choice, and lane/facility choice. When comprehensively applied, TSMO strategies can influence many stages of the trip chain and influence the supply and demand sides of transportation management. Different TSMO strategies can influence different parts of the trip chain, so the focus is more on the influence of TSMO in making short-term, real-time changes to traveler behavior based on prevailing conditions than it is on long-term, habitual, and static changes to traveler behavior.

The behavior of motorists is a critical component to the understanding of TMSO, as motorists make dynamic decisions based on the situations they expect and incur during their travel. In turn, these decisions affect the overall network performance beyond the local setting of any given strategy. Understanding, cataloging, and communicating these impacts are critical to the continued and successful application of TMSO strategies.
The objective of this research is to identify how deployed TSMO strategies affect the dynamic decisions travelers make in destination choice, time of day choice, mode choice, route choice, and lane/facility choice, and the network performance changes because of the choices travelers make due to TSMO strategies.

**Project 08-176**

*Balancing Freight and Goods Delivery Needs Into Designing Complete Streets of the Future*

Research Field: Transportation Planning  
Source: AASHTO Committee on Planning  
Allocation: $500,000  
NCHRP Staff: Camille Crichton-Sumners

The Infrastructure and Investment Jobs Act (IIJA) introduced new provisions important to freight needs and Complete Streets policies, defining Complete Streets as standards or policies that “ensure the safe and adequate accommodation of all users of the transportation system, including pedestrians, bicyclists, public transportation users, children, older individuals, individuals with disabilities, motorists, and freight vehicles.” With new requirements that 2.5% of planning funding must be dedicated to activities related to Complete Streets, freight must be considered an important factor. With the rise of e-commerce and smaller delivery vehicles, curbside management concerns, bicycle and pedestrian considerations, and other factors, this research is needed to reconcile the needs of a true Complete Streets approach. The ability to address the needs of active transportation and freight will continue to be important to state department of transportations (DOTs) and local entities, and this research will benefit planners as they navigate these seemingly (and at times actually) competing needs. This research will take a context-appropriate approach to help practitioners evaluate what to do if there is a conflict.

While many research efforts related to freight and land use are currently underway, there is no substantive research that addresses the integration of freight needs into Complete Streets planning and policies on a national level. This research will focus less on existing practice and more on identifying gaps and what is needed for the future. It will be important for this research to be forward-thinking and consider compatibility with and the opportunity to integrate new and emerging factors, such as connected and automated vehicles, the rise of e-commerce, and new micromobility modes, to create more comprehensive and cohesive networks.

The objective of this research is to develop a guide and tools for balancing the unique needs of freight into Complete Streets designs, policies, and considerations. Key components of the research include:

1. Developing a guide that seamlessly integrates freight into Complete Streets policy as an integral part of defining a Complete Street;  
2. Summarizing essential conflicts of street use and potential ways to address them;  
3. Developing and illustrating best practices for government practitioners and decision-makers on approaches to better integrate freight into cities in the future; and  
4. Identifying policies, relationships, procedures, and processes needed for state, regional and local governments, and interested stakeholders.

**Project 08-177**

*Digitizing Bicycle and Pedestrian Treatments for Promoting Active Transportation Equity and Safety*

Research Field: Transportation Planning  
Source: California Department of Transportation  
Allocation: $500,000  
NCHRP Staff: Arefeh Nasri

Traffic risks involving nonmotorized road users have been a significant problem in recent years, with many fatalities observed in underserved and low-income communities due to lack of adequate nonmotorized
infrastructure. However, implementing data-driven safety and planning tools is challenging due to the absence of a high-quality inventory database for bicycle and pedestrian treatments. Therefore, it is crucial to develop and maintain a high-quality inventory database for such treatments. The resulting project will advance the application of GIS data acquisition to develop a framework for data acquisition and digitization to manage active transportation-related road assets while minimizing costs and risks associated with poorly governed data. This study will not only aid safety assessment by developing crash modification factors for active transportation facilities and treatments but will facilitate equity assessment and informed decision-making during the planning process.

The objective of the project is to develop procedures to assist state department of transportation (DOTs) in digitizing bike and pedestrian treatments. This will involve the following steps:

- Conduct a survey of state DOTs to understand their current practices and data needs regarding bicycle and pedestrian treatments.
- Investigate existing market solutions and emerging geographic data sources and develop a concept of operations for digitizing bicycle and pedestrian treatments.
- Develop a GIS-based framework for digitizing and sharing bicycle and pedestrian treatments.
- Address uncertainty issues related to emerging geo-data, such as inaccuracy, redundancy, and heterogeneity.
- Identify any legal issues associated with digitization and data management.
- Design effective validation and certification procedures to assess the quality of digitized information.
- Develop procedural concepts for necessary data collection, upkeep, and management, and compile them into a guide.

These research steps will help address the lack of inventory data for active transportation facilities and treatments and will facilitate the development of a GIS-based protocol to fill the data gap. The resulting guide will provide procedural concepts for collecting, maintaining, and managing data, and will be used to suggest changes to AASHTO and FHWA publications. State DOT officers will be contacted for implementation guidelines, and a detailed guideline document will be prepared with precise definitions of terms and operating procedures.

Direction from the AASHTO Committee on Research & Innovation: Expand field data collection to include vehicle treatments esp. ones affecting bicycles/peds.

Project 08-178
Methodologies for Identifying and Evaluating Transportation Infrastructure that has Historically Divided Communities

Research Field: Transportation Planning
Source: Massachusetts Department of Transportation
Allocation: $500,000
NCHRP Staff: Trey Joseph Wadsworth

The recently passed Bipartisan Infrastructure Law (BIL) contains funding for a new Reconnecting Communities Pilot (RCP) Program, which aims to connect historically divided and disconnected communities. Additionally, the Inflation Reduction Act contains $3 billion to fund Neighborhood Access and Equity Grants, that aim to rework overbuilt arterial roads and make them safer and more accessible for various modes of transportation. These new grants can be leveraged by state departments of transportation (DOTs) to build connections across highways and railroads and redesign roads dangerous to cross.

Few resources currently are available for state DOTs and others to rely on to identify possible locations for projects that address historically divided or disconnected communities. Although the adverse outcomes of a handful of previous major infrastructure projects are well documented, several other locations have suffered
similar detrimental effects. However, they are not as well-known or as easy to identify. As such, state DOTs would benefit from resources and methods to better assess these locations and understand which types of land use and transportation characteristics to look for when prioritizing projects in the spirit of reconnecting communities.

This research project will identify resources and methods to be used across different geographies and at different scales to assist state DOTs to identify locations that have become disconnected from employment, recreation, and commercial centers as a direct result of past infrastructure investments. Additionally, this research will provide guidelines for infrastructure project scopes of work for building connections across infrastructure that have divided communities.

**Project 08-179**  
*State DOT and MPO Planning Coordination: Enhancing the 2016 Regional Models of Cooperation Handbook*

Research Field: Transportation Planning  
Source: AASHTO Committee on Planning  
Allocation: $500,000  
NCHRP Staff: Trey Wadsworth

In 2016, the Federal Highway Administration published the *Regional Models of Cooperation Handbook*. Since then, additional efforts necessitate cooperation between state departments of transportation (DOTs) and metropolitan planning organizations (MPOs) and specify that transportation plans must be consistent with other plans. These plans, in addition to transportation systems development, include land use, employment, economic development, human and natural environment (including Section 4(f) properties), and housing and community development.

As state DOTs and MPOs bring new stakeholders into the transportation planning and programming processes, there are corresponding increases in conflicting viewpoints or desired outcomes. A typical response is the transportation plans either reference the other plans or provide cursory acknowledgment of the other plans. As a result, opportunities to further integrate or harmonize transportation planning and programming documents are becoming more complex and more necessary.

The objective of this research is to update the 2016 *Regional Models of Cooperation Handbook* to increase the integration of planning and programming among state DOTs and MPOs from cooperation to coordination and collaboration. In addition, recommendations and proven methods will be identified for state DOTs and MPOs to simplify partnership and collaboration to unify statewide and metropolitan plans and programs. Examples, recommendations, and proven methods will be identified for state DOTs, MPOs, and designated transit funding recipients to cooperate during transportation planning and programming.

**Project 08-180**  
*Streamlining Tools for Cultural Resources Compliance in Response to Federally Mandated Timeframes*

Research Field: Transportation Planning  
Source: Ohio Department of Transportation  
Allocation: $300,000  
NCHRP Staff: Jennifer L. Weeks

This proposal seeks to identify effective methods and develop tools for transportation cultural resource practitioners to facilitate timely consultation as required by Section 106 of the National Historic Preservation Act (NEPA) within the compressed timeframes specified under the Bipartisan Infrastructure Law (BIL). The now-rescinded Executive Order (EO) 13807 established goals of 2-year completion of environmental impact
statements and 1-year completion of environmental assessments. While EO 13807 and “One Federal Decision” (OFD) requirements have been rescinded, the BIL and Council of Environmental Quality’s (CEQ) 2020 updated NEPA regulations maintain these timeframe expectations without providing access to available supporting tools (such as an interagency OFD Memorandum of Agreement) that facilitated consultation under EO 13807. Departments of transportation (DOTs) have been using ad-hoc and existing tools to meet accelerated timelines, such as Planning and Environmental Linkages (PEL) studies; extended pre-NEPA/Notice of Intent (NOI) studies; simplified review or historic contexts for common resource types; and programmatic agreements. However, these streamlining options, if improperly used, may cause significant project risks in insufficient resources inventories, potential appearance of project segmentation, insufficient evaluation of avoidance alternatives, or foreclosure of consultation before issuance of decisions.

This project seeks to develop a guide and tools to help agencies meet mandated cultural resource consultation and documentation timeframes. Examples of methods and tools to explore include technological solutions (improving web-based/virtual consultation, predictive models), process improvements, management practices and other methods. The research will draw upon lessons learned from successful project delivery to identify professional practices that result in robust community consultation; thorough historic property identification and evaluation; and due diligence consideration of impacts.

The project and its resulting products will facilitate greater adherence to the mandated timelines, and thus minimize litigation risk and project delays. The benefits of having a nationally informed guide, methods, and tools will assist with consistency and defensibility of Section 106 documents nationwide and provide a baseline for additional innovation in the areas of identifying efficiencies in the Section 106 review process.

Project 08-181
Understand How Climate Change and Extreme Weather Impacts the Mobility of Socially Vulnerable Populations

Research Field: Transportation Planning
Source: California Department of Transportation
Allocation: $500,000
NCHRP Staff: Dianne Schwager

The impacts of climate extremes are acute on the mobility of socially vulnerable populations. When extreme weather events occur, vulnerable populations are more likely to experience travel delays, road damage, route closure, detours, or complete impassibility, effectively blocking their access to life-saving infrastructure and services (e.g., healthcare and emergency resources). Slower onset climate impacts events reduce their mobility by crippling transportation infrastructure or making it physically uncomfortable or unsafe to travel to perform daily activities (e.g., work, shopping, schooling, or healthcare). By diminishing access to life-saving resources and services, jobs, schools, political events and civic activities, the impacts of compromised mobility include not only short-term perturbations and dangers, but also long-term social, economic, and political exclusion.

Equity and justice in climate adaptation is an emerging area of research and practice in transportation. There is limited research on how direct physical impacts on the transportation systems interact with non-physical factors, such as human decision-making, behavior, and social and institutional processes, to amplify the mobility burdens for those groups. However, the issue is gaining traction in the research community and across various government agencies.

The objective of this research is to help state departments of transportation (DOTs) understand how climate change and extreme weather impact socially vulnerable groups, especially those with fewer resources to adapt. The research should distinguish how the impacts of climate change and extreme weather (e.g., hurricanes, floods, wildfires, and extreme heat and cold) can affect different subpopulations (e.g., income, race, education, language isolation, and physical conditions) and how transportation investments can improve resilience for these
communities in the near- and longer-terms. Information on the impacts of specific climate risks on vulnerable groups can help state DOTs and metropolitan planning organizations (MPOs) design and implement strategies to address related mobility burdens and support recovery in those communities.

Project 08-182
Using System Performance Data to Communicate Benefits of Transportation Systems Management and Operations (TSMO) Strategies

Research Field: Transportation Planning
Source: Texas Department of Transportation
Allocation: $400,000
NCHRP Staff: Zuxuan Deng

In recent decades, many agencies have embraced concepts that fall under the Transportation Systems Management and Operations (TSMO) umbrella and have deployed TSMO strategies. While most transportation professionals understand conceptual improvements provided by these strategies, agencies continue to struggle to communicate these benefits in a consistent, meaningful, and persuasive way to the varied audiences that need that information.

The availability or volume of data is not the primary issue because a significant increase in the variety and volume of data has coincided with the deployment of TSMO strategies. Not only do some TSMO strategies include systems that produce their own data, but agencies have increased access to legacy datasets within the agency along with new datasets based on mobile and other sources. With this new data, researchers have worked to store, organize, validate, combine, and analyze these new datasets to create usable information and performance measures. These efforts resulted in relatively new and useful performance measures such as those focused on freeway and arterial reliability. However, even with this increased access to data, agencies struggle to tie system performance to specific TSMO strategy deployments that may have benefits beyond spot locations and synergistic effects with other TSMO strategies, and to consistently communicate benefits of these TSMO strategies to the varied stakeholders in their areas, which range from agency leadership to regional partners, the public, and national organizations.

The objective of this research is to provide recommended practices for using data and performance measures to communicate the benefits of TSMO strategies and tactics to stakeholders at the agency, regional, and national levels and the public. This research will create guidelines for communicating the benefits of TSMO strategies to various stakeholders and will include the following components: (1) assess the current state of practice for measuring the benefits of specific TSMO strategies and tactics; (2) summarize the needs for agencies at multiple levels (local, regional, and national) and public stakeholders for understanding the benefits of TSMO strategies; (3) perform a gap analysis to determine differences in current benefits measurements and the needs of each of the stakeholders; and (4) provide recommendations for consistent communication of TSMO benefits to each stakeholder group, including measurement methods, content, and communication methods.

Project 08-183
Volunteer Driver Programs (VDPs) Serving Rural and Low-Density Communities

Research Field: Transportation Planning
Source: AASHTO Committee on Public Transportation Council
Allocation: $350,000
NCHRP Staff: Dianne Schwager

Many people in North America are facing a future where aging may compromise their ability to drive a personal automobile. When it comes to alternatives to driving, older adults tend to seek it from friends and family.
However, a variety of factors make it difficult for older adults to rely exclusively on friends and family to meet their travel needs.

Volunteer driver programs (VDPs) can be an effective means to accommodate unmet mobility needs of older adults and other transportation-disadvantaged people in rural and low-density communities. There is potential for these programs to be implemented or expanded on a coordinated basis to provide low-cost and accessible transportation in underserved or unserved rural communities; however, there is limited understanding of what makes a successful, sustainable, and replicable VDP.

Consequently, it is difficult for state departments of transportation (DOTs), public transit and human services agencies, or regional transportation authorities to estimate the potential benefits of VDPs, determine prospective costs and benefits, and identify where and when VDP models will be successful and sustainable. This limits the ability of rural public transit agency staff, mobility managers, and transportation planners to consider, plan, implement, and sustain VDPs among a continuum of transportation services.

The objectives of a national research effort on VDPs are to support the development of a seminal publication that:

- Identifies existing VDPs in North America, particularly in rural or low-density areas, and available resources on these programs, including tools for planning services or monitoring and dispatching volunteers.
- Presents the potential for VDPs as a viable transportation alternative in rural or low-density areas to provide additional transportation options for seniors, persons with disabilities, and other travelers.
- Identifies the types of metrics and methods for monitoring performance that will be valuable for transportation planning and aligned with the VDPs capacity to provide service and improve equity of available mobility options.
- Identifies sustainable funding sources and mechanisms for VDPs in rural or low-density areas.
- Creates an organizational complexity model (i.e., maturity model) tool that presents success factors and best practices of VDPs in rural or low-density areas and identifies criteria/factors for success.
- Documents the societal benefits of enhancing VDP as a mobility option for nondrivers and drivers in transition.

This project can lead to improved safety by helping expand mobility solutions at a point where the health effects of aging may make driving difficult or impossible.

**Project 08-184**

*Framework for Assessing Induced Demand Effects of Various Roadway Investments*

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<th>Research Field:</th>
<th>Transportation Planning</th>
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<tr>
<td>Source:</td>
<td>Ohio Department of Transportation</td>
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<td>Allocation:</td>
<td>$450,000</td>
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<td>NCHRP Staff:</td>
<td>Trey Joseph Wadsworth</td>
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Operational improvements such as auxiliary lanes and intelligent transportation system treatments are designed to reduce congestion. Even minor congestion improvement strategies and investments intended to optimize existing roadway system assets are increasingly facing opposition due to the concept of induced demand, often pointing to potentially disparate impacts on Environmental Justice (EJ) communities. The public lacks trust that the traffic analyses accurately account for induced demand and raises concerns about such projects’ increased greenhouse gases (GHG) and air quality impacts. Recognizing that even operational and safety improvements may have some level of induced demand, state departments of transportation (DOTs) need to understand their potential unintended consequences better.
A definitive study of major and minor capacity enhancements on freeways and arterials, as well as mitigation options, is needed to improve state DOT investment decisions for the long term and enable more productive conversations with the public. The public and interested groups are using induced demand arguments to oppose new roadway investments and small operational and safety roadway projects by state DOTs nationwide. To invest responsibly – balancing safety, economic, equity, and climate concerns – state DOTs need to understand better the actual effects of these projects, especially of more minor roadway treatments and other mitigation options. Additionally, with tough tradeoffs, state DOTs would engender more public buy-in through more nuanced discussions. This study would provide a broader understanding of effective roadway congestion strategies. It would help state DOTs avoid investing in projects/treatments that, if left unmitigated, are unlikely to achieve their intended goals.

The objective of this research is to create a framework for (1) analysis and (2) communications that will demonstrate state DOTs factor in induced and latent demand while identifying mitigation factors. The effort should note particular circumstances or gaps in case study data collection and research that might require further investigation.

Project 09-70
Feasibility Evaluation and Guidance Development for Implementing Practical Aging Protocols for Balanced Mix Design (BMD) Verification and Acceptance

Research Field: Materials and Construction
Source: AASHTO Committee on Materials and Pavements
Allocation: $1,000,000
NCHRP Staff: Amir N. Hanna

There is a consensus among state highway agencies (SHAs) and the asphalt pavement industry that mixture aging should be considered when evaluating the cracking resistance of asphalt mixtures in a balanced mix design (BMD) framework. In general, aging yields asphalt mixtures with improved rutting resistance but with reduced cracking resistance and durability. Field aging of a specific mixture is influenced by production conditions, climate, and sensitivity to oxidation and subsequent rheological response that can vary greatly depending on many mix design factors, which include but are not limited to selection and proportions of virgin component materials of different sources and types; the use of reclaimed asphalt pavement (RAP), recycled asphalt shingles (RAS), or other recycled materials; and the incorporation of asphalt additives (e.g., warm mix asphalt additives, anti-stripping agents, recycling agents, etc.)

Over the years, different long-term mixture aging protocols have been developed for mixture performance testing and prediction. Although some of the protocols have shown promising results in a research environment, they are not practical for use in BMD verification and acceptance (i.e., production quality assurance) where a quick turnaround on the test results for plant-produced mixtures is desired. Because of this limitation, many SHAs elect to either not require BMD performance tests during production or only conduct the tests on specimens reheated or short-term aged. Although using the short-term aged test results sometimes discriminates the cracking resistance of asphalt mixtures, this practice may not be sufficient to ensure that the mixtures will have adequate long-term cracking resistance in the field, especially for those containing additives that could affect the aging sensitivity of asphalt mixtures.

To address this limitation, the asphalt research community has suggested using the short-term aged cracking test results along with an aging correction factor (ACF) to estimate the long-term results for mix design verification and acceptance. For this approach, an ACF must be established as part of the mix design development process, or possibly during trial mix production (i.e., test strip), by conducting the selected cracking test(s) at multiple aging conditions. Although this approach appears promising conceptually, its feasibility, robustness, and practicality for field practice is yet to be determined. There is limited information available on how an ACF can be developed from cracking test results at different mixture aging temperatures and durations, and how reliable
the ACF is in terms of its ability to predict the long-term aged cracking test results. Furthermore, it remains unknown how the ACF varies among asphalt mixtures with a range of mix design factors and production and climatic conditions, and whether a relationship between binder aging and mixture aging exists that can possibly be used to simplify the ACF development process.

The overall objective of the proposed research is to evaluate the feasibility and develop guidelines for implementing practical asphalt mixture aging protocols for BMD verification and acceptance. Specifically, this research seeks to (1) determine the feasibility, robustness, and practicality of using the aging correction methodology to predict the long-term aged cracking test results of plant-produced mixtures (using either hot-compacted or reheated plant mixed-laboratory compacted specimens) for mix design verification and production acceptance; (2) valuate the sensitivity of the developed methodology to different asphalt mixture components and proportions; (3) provide a framework for developing a generic or mixture-specific aging correction methodology based on BMD cracking test results at multiple aging conditions during mix design; and (4) suggest a work plan to be used by SHAs to verify the developed guidelines using BMD shadow or pilot projects.

Project 09-71
Guidance to Develop Optimized Framework of Asphalt Mixture Performance Testing for Balanced Mix Design and Acceptance (BMD&A)

Research Field: Materials and Construction
Source: Texas Department of Transportation
Allocation: $850,000
NCHRP Staff: Amir N. Hanna

Many state departments of transportation (DOTs) are currently exploring and implementing Balanced Mix Design (BMD) systems for asphalt mixtures. This trend reflects the need to ensure a high quality of the binder that represents a blend of virgin unmodified or polymer-modified asphalt, recycled materials [reclaimed asphalt pavement (RAP), recycled asphalt shingles (RAS), and/or plastics], and additives (warm-mix, anti-stripping, recycling agents, and/or other) whose impact cannot be accounted for by volumetric quantities. This approach represents a significant change by requiring performance tests to ensure balanced resistance to rutting and cracking of the complete mixture as opposed to verifying individual component properties with largely unknown interactions in combination.

Mixture performance tests for these primary distress types can utilize monotonic or repeated loading, and there is an array of tests of both types. Monotonic tests are more time- and cost-efficient and less variable than repeated-load tests, but repeated-load tests better represent the repeated traffic and environmental loading cycles that asphalt pavements experience in service. Repeated load tests and subsequent performance prediction are also tied to efforts to develop performance related specifications (PRS). In addition, different tests are sensitive to important factors such as component materials, proportions, and aging that drive performance. Finally, the timeframe available for testing associated with mix design is longer than that during production for quality assurance (QA) and acceptance and payment. Thus, state highway agencies (SHAs) would substantially benefit from guidance to identify and implement an optimum combination of mixture performance testing for an integrated balanced mix design and acceptance (BMD&A) system.

The objective of this research is to develop a framework for implementing an optimum combination of asphalt mixture performance testing for an integrated system of BMD&A. Specifically, this research seeks to (1) identify alternate approaches with combinations of monotonic and/or repeated loading to capture balanced mixture performance; (2) compare multiple approaches with respect to impact on and sensitivity to aging and specimen fabrication and testing procedures (including reheating plant-produced mix; ability to differentiate mixtures with different component materials and proportions; and time requirements, costs, and available information tied to field performance; (3) provide tiered examples of application of and time and cost requirements associated with integrated systems of BMD&A based on sensitivity and test variability analyses that identifies trade-offs in risk
and cost and includes guidance on selection of performance-optimized asphalt content in a range of scenarios; and (4) propose guidance and a methodology to identify and implement an optimum combination of SHA-selected asphalt mixture performance tests for an integrated system of BMD&A including verification with field test sections to compare alternate approaches.

Direction from the AASHTO Committee on Research & Innovation: Include scope from unfunded problem statement D-10.

Project 09-72
Sensitivity Evaluation of Balanced Mix Design Performance Tests to Binder Properties and Mix Design Variables

Research Field: Materials and Construction  
Source: Montana Department of Transportation  
Allocation: $500,000  
NCHRP Staff: Amir N. Hanna

The selection of Balanced Mix Design (BMD) performance tests relies on the assumption that they can discriminate between various elements of a mix design that are known to have positive or adverse effects on mixes. However, it is critical to determine which tests and thresholds are sensitive to the many moving parts in a mix design formula, such as binder source, binder grade, polymer modification, aggregate gradation, aging, and reclaimed asphalt pavement (RAP)/recycled asphalt shingles (RAS) content. Meanwhile, the difficulties in choosing tests and thresholds are further complicated by new materials introduced that lack long-term performance data, which makes the choice of tests that can accurately describe cracking and rutting resistance more critical. Finally, the problem is also complicated by common producer-side substitutions such as grade bumping or change of binder source with the same grade.

This suggested research seeks to (1) evaluate the sensitivity of BMD performance tests to common mix design variables, including but not limited to, binder source, binder grade, polymer modification, aggregate gradation, aging, and RAP/RAS content and lab processing methods; (2) evaluate the correlation between different BMD rutting and cracking tests and provide guidance on how to integrate the results; and (3) identify the limitations associated with various mixture performance tests for BMD implementation.

Project 10-126
Develop a Standard Testing Protocol for the Approval of Field-cured Products for Use on DOT Projects

Research Field: Transportation Planning  
Source: Ohio Department of Transportation  
Allocation: $350,000  
NCHRP Staff: Trey Joseph Wadsworth

State departments of transportation (DOTs) routinely receive requests from product or material vendors to approve their items for use in state DOT projects or maintenance operations. Many of these products involve a spray, foam, epoxy, or resin that requires an in-the-field cure during installation. Although manufacturers typically can provide evidence of meeting required laboratory testing standards, several studies have documented adverse effects on water quality during and after installation. These effects are often a result of insufficient curing of the material or some degree of permeability in the product designed to contain the cured material. Although some state DOTs have developed specifications for specific repair methods to mitigate these effects, it is difficult for state DOTs to keep pace as new technologies and products are marketed.
As new infrastructure construction and rehabilitation materials are continually introduced into the transportation market, the costs of evaluating the environmental impact of each product are not sustainable for state DOTs. This research will result in guidelines for the testing protocols and transferring the testing responsibility to the manufacturers, saving state DOTs costs and reducing the risks of approving products that may result in adverse environmental effects. It will also provide a level of reliability against stream contamination by putting in place safeguards against the use of materials that could adversely affect aquatic life.

The objective of this research is to develop a standardized material testing protocol for materials that require an in-the-field cure (e.g., resin, spray, foam, or epoxy) and are primarily used in applications that convey streams or are in direct contact with bodies of water. The standardized test method developed should apply to a wide range of products and installation procedures. Such a protocol will allow state DOTs to transfer the responsibility for testing the environmental impacts to the vendors prior to approval. The project findings should also be used to recommend restrictions and specifications for the use of these products.

Direction from the AASHTO Committee on Research & Innovation: Needs further clarification of scope and which material looked at.

**Project 10-127**

*Impact of Tension Flange Holes on the Strength and Ductility of Composite Steel Girders*

Research Field: Materials and Construction  
Source: Indiana Department of Transportation  
Allocation: $250,000  
NCHRP Staff: Ahmad Abu-Hawash

The *AASHTO LRFD Bridge Design Specifications* (BDS) provides a limit on the maximum major-axis bending stress permitted on the gross section of a steel girder, neglecting the loss of area due to holes in the tension flange, when checking flexural members at the strength limit state or for constructability. This is used in lieu of the 15 percent rule that had existed in older AASHTO design specifications, which allowed holes with an area less than or equal to 15 percent of the gross area of the flange to be neglected. For higher-strength steels, with a higher yield-to-ultimate tensile strength ratio (Y/T ratio) than Grade 36 steel, which was the most common grade of structural steel back when the 15 percent rule was initially applicable, the 15 percent rule is not valid; such steels are better handled using *AASHTO LRFD BDS* Eq. 6.10.1.8-1. However, because of concerns about potential early rupture of the critical net section in tension flanges of girders composed of steels with higher Y/T ratios, and/or in tension flanges of composite girders in regions of positive flexure where the neutral axis is relatively high in the cross-section and the inelastic deformation demands on the tension flange may be larger, an upper limit of Fyt (where Fyt is the specified minimum yield strength of the tension flange) is currently conservatively enforced in Eq. 6.10.1.8-1.

The objective of this research is to further study the impact of tension flange holes on the strength and ductility of composite steel girders, focusing primarily on the impact on girders utilizing steels with higher Y/T ratios and on the tension flanges of composite girders in regions of positive flexure where the neutral axis is relatively high in the cross-section and the inelastic deformation demands on the tension flange are typically larger. The research should determine if modifications can be made to the existing *AASHTO LRFD BDS* Eq. 6.10.1.8-1 to ensure that adequate strength and ductility can be achieved, while attaining a targeted level of reliability, prior to net section rupture of the tension flange under the larger inelastic deformation demands as the section exceeds the moment at first yield and approaches the plastic moment resistance.
The effect of various parameters such as the Y/T ratio and the dimensional characteristics of the cross-section should be considered. The research should focus on Grade 50 and Grade HPS70W steels as a minimum, and perhaps include Grade HPS100W steels if the budget permits. It is anticipated that the research would be based primarily on analytical investigations. Based on the research findings, the research team should propose revisions/additions to the AASHTO LRFD BDS in the form of draft ballot items.

**Project 10-128**

*Advancing Multi-Sensor Weigh-In-Motion (WIM) Technology for Improving Weight Data Accuracy and Reliability.*

Research Field: Materials and Construction  
Source: North Carolina Department of Transportation  
Allocation: $450,000  
NCHRP Staff: Camille Crichton-Sumners

Weigh-in-motion (WIM) data is essential for design and maintenance activities related to pavement and bridge infrastructure and for monitoring and enforcing motor carrier truck weights and dimensions. State departments of transportation (DOTs) require accurate and cost-effective WIM technology. WIM sensors vary from instrumented metal plates to piezoelectric, quartz, and strain gauge strip sensors. Their accuracy is evaluated with reference to static loads (ASTM E1318) and is affected by the interaction between roadway roughness and vehicle dynamics and speed. This affects the narrow strip-type WIM sensors that sample a smaller part of the dynamic axle loads applied to the road and may potentially be mitigated by using multiple strip sensors (two or more) strategically spaced to capture more data points of the dynamic axle load waveforms. The result will be increased reliability and more accurate estimates of the applied static axle loads. The use of multi-sensor WIM sensors is potentially cost-effective, may reduce measurement error, improve data quality, and reduce maintenance costs.

The objectives of this project are to (1) determine the feasibility of utilizing multiple sensors for improving the accuracy and reliability of WIM systems; (2) quantify costs and benefits of multi-sensor arrays; (3) develop a methodology for designing optimum sensor array; and (4) program controllers to optimize the output and record weights from multiple WIM sensors.

**Project 10-129**

*Field Studies of Steel Girder Fit-up*

Research Field: Materials and Construction  
Source: Indiana Department of Transportation  
Allocation: $300,000  
NCHRP Staff: Ahmad Abu-Hawash

The fit condition of a steel I-girder bridge refers to the deflected geometry associated with a specific load condition in which the cross-frames or diaphragms are detailed to connect to the girders. With respect to vertical deflection, there are three fit conditions for steel girder bridges: no-load fit (NLF), steel dead load fit (SDLF), and total dead load fit (TDLF).

Consideration of the fit condition is important because the appropriate fit decision can provide significant benefit to the constructability and the overall performance of the bridge system. The AASHTO LRFD Bridge Design Specifications (BDS) (Article 6.7.2) specify that the fit condition of the cross-frames or diaphragms should be clearly stated in the contract documents for straight I-girder bridges with skewed supports and horizontally curved I-girder bridges with or without skewed supports. If the appropriate fit condition is not selected, the bridge could be subjected to problems during erection and construction. It also could result in systems that have errors in final steel vertical profile and cross-slope or other long-term problems.
The objective of this research is to investigate the condition of steel girders in the field originally detailed for different fit conditions and compare analytically. It will include field measurements of existing steel girder systems to determine the condition of the girders relative to the design. Researchers will compare the field results to the fit condition that the girders were fabricated to. Based on field studies, current guidelines may be revised and/or new guidelines on best detailing practices impacting girder fit-up may be established. At a minimum the research will include the following tasks.

- Finite element (FE) analysis.
- Existing Bridge Selection – Identify bridge candidates for field testing. The research team would obtain fabrication shop drawings for each bridge selected.
- Field measurements of selected bridges.
- FE model calibration and parametric studies – The research team would calibrate the FE Model based using the field results. The research team would perform parametric studies, using FE analysis, to investigate the different results of girder fit condition. The team will include different girder sizes and spans, horizontal curvature, skew angle, and other design variables in their study.
- Review existing guidelines and develop new guidelines – The research team will review existing guidelines regarding steel bridge fit and offer revisions if necessary, or develop new guidelines for choosing the best detailing method for steel girders.
- Develop specification language – The research team would review all results and propose revisions or additions to the AASHTO LRFD BDS if their recommendations differed from current practice.

Project 10-130
Guidebook for Using Alternative Contracting Methods for Small Highway Projects

Research Field: Materials and Construction
Source: Minnesota Department of Transportation
Allocation: $400,000
NCHRP Staff: David Jared

Use of alternative contracting methods (ACMs), such as design-build (DB), construction manager/general contractor (CM/GC), and public-private partnerships (P3), have been shown to improve project performance on transportation projects. While the use of ACMs is increasing, they account for a small portion of overall project delivery among state departments of transportation (DOTs). Also, most of the successfully completed ACM projects have been large projects, with project costs over $20 million. For smaller projects, project with costs less than $20 million, there are fewer examples where DB has been used for rehabilitation or reconstruction projects on bridges, roads, or intelligent transportation systems. In some state DOTs, non-use of ACMs has centered on large size projects and the concern that it eliminates smaller, local companies from competing.

There are unique challenges for using ACMs on projects of less than $20 million, which requires research specifically focused on these challenges and opportunities. To expand the use of ACMs to smaller projects, a better understanding of the following items is needed: (1) factors that affect duration and scope of the procurement process; (2) appropriate allocation of risks based on project size; (3) factors that affect cost effectiveness from the owner and contractor; and (4) benefit and drawbacks to owners. The current lack of information regarding effective procurement and utilization of ACMs for small projects inhibits the ability to expand their use to smaller transportation projects.

The objectives of this research are to (1) establish effective practices in the use of ACMs such as DB, CM/GC, and P3 for small projects in transportation; and (2) develop a guide for DOTs to evaluate the potential use of ACMs for small projects and how to effectively implement ACMs for small projects. This research will use a
series of case studies to identify effective practices and limitations associated with using ACMs for small projects. The study will identify any statutory limitations on the use of ACMs specifically for smaller projects.

Many DOTs have small projects that would benefit from the use of ACMs, whether by reducing the project delivery time, reducing staffing challenges to deliver these projects in-house, bundling of smaller projects or bringing in private financing to expand the number of projects. Without guidance on the use of ACMs for small projects, DOTs may not consider this valuable tool or may suffer from use of guidelines developed for larger projects. Developing effective practices for the use of ACMs for small projects is a natural continuation of the research that has demonstrated the value of ACMs for larger projects.

### Project 10-131

#### Implementation of Full-Scale Laboratory Tests to Determine Performance Properties of Geosynthetic-Reinforced Pavements

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<tr>
<td>Source:</td>
<td>North Carolina Department of Transportation</td>
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<td>Allocation:</td>
<td>$750,000</td>
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<td>NCHRP Staff:</td>
<td>Amir N. Hanna</td>
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Even though geosynthetics are known to improve the structural capacity of pavements, they still tend to be underutilized. Part of the reason is the lack of reliable and non-proprietary performance data, leaving engineers to rely more heavily on proprietary software and/or their own judgment rather than definitive results from research and testing efforts. Having a publicly available, unified method to determine the performance of geosynthetics used as structural benefit in roadway applications would improve impartiality and simplify the use of these products.

Traditionally, the benefit of geosynthetics to the structural capacity of pavements has been defined by the Traffic Benefit Ration (TBR) derived from non-standard testing ranging from small laboratory simulations to monitored full-scale test sections. The uncertainty introduced by the lack of comparability of TBRs, resulting from testing done at different scales and using different protocols, has contributed to the underutilization of geosynthetics in pavement designs. Thus, a standardized performance test method is needed to reduce uncertainty and potentially increase utilization of geosynthetics in roadway applications. A standardized test method to determine the performance of geosynthetics used as structural support in roadway applications was recently published through ASTM (ASTM D8462, Standard Test Method for Cyclic Plate Load Tests to Evaluate the Structural Performance of Roadway Test Sections with Geosynthetics). This standard was developed based on protocols initially summarized in a paper by Berg et al. in 2000.

The performance property derived from the cyclic plate load (CPL) test is Stationary-Traffic Benefit Ratio (S-TBR). S-TBR differs from standard traffic benefit ratio (TBR) determined using rolling wheel load tests, which are controlled tests conducted on roadways trafficked by a truck or an accelerated pavement testing (APT) device outfitted with a rolling wheel. While full-scale rolling wheel load tests are more akin to applied traffic on roadways, the primary advantages of the CPL test are (1) individual test sections are smaller and therefore easier to build, (2) trafficking can be applied 5-10 times faster, and (3) material properties and construction are easier to control because volumes are smaller. However, few studies have been conducted to definitively correlate results of the smaller scale CPL device to results of testing using a full-scale rolling wheel. The addition of this information will help improve designer’s confidence by lowering perceived risks, and further stimulate the use of geosynthetics to increase the structural capacity of highways, thereby decreasing overall life-cycle costs.

The primary objective of this research is to correlate the results of standard CPL tests with rolling wheel tests to establish the CPL test as an appropriate non-proprietary method to quantify the performance-related attributes of geosynthetics used as reinforcement in roadways for design purposes. Complementary objectives include researching the parameters of the CPL test apparatus and test protocol to ensure the device, loading scheme, and
Construction techniques do not favor or inadvertently impair certain configurations or geosynthetic products for this application. The primary tasks associated with this effort are (1) perform a comprehensive literature review of performance tests for geosynthetic-reinforced roadway applications, (2) design an experimental program, (3) conduct performance tests on a variety of road configurations (full-scale rolling wheel load tests; CPL tests; static plate load tests; paved and unpaved designs; using various subgrade, base course, and asphalt properties and thicknesses), (4) conduct a parametric study using modeling based on the results of the laboratory tests to corroborate and correlate measured pavement performance, (5) outline refinements to performance tests to ensure accurate and repeatable results, and (6) write a comprehensive final report with recommendations for implementation.

**Project 10-132**

*Improving Bridge Resiliency Through Understanding the Interaction Between Pier and Contraction Scour, Total Scour Components, and Developing Scour Profiles.*

Research Field: Materials and Construction  
Source: Georgia Department of Transportation  
Allocation: $800,000  
NCHRP Staff: Ahmad Abu-Hawash

Scour has a major effect on the design, construction, and maintenance costs of bridges. Improving understanding of the interaction between pier, contraction, and abutment scour is key to the cost-effective design of foundations. The interaction between pier and contraction scour is a topic without much study; how the pier presence affects the depth and extent of contraction scour is unknown.

The current practice is to estimate scour components separately and compute the total scour as the sum of the individual components. This practice leads to the overestimation of scour potential, thereby causing an increase in design, construction, and maintenance costs. Better understanding of the interaction between scour types and which scour types control overbank and channel scour potential could lead to significant cost savings. This would include the study of the interaction of the concept of total scour from a system perspective and the development of 2D and 3D scour profile guidance.

The objective of this research is to determine the interaction between pier, contraction, and abutment scour through data collection and conducting flume/computational fluid dynamic (CFD) studies. This would lead to the development of guidelines on how to determine the interaction between pier and contraction scour and to determine total scour potential. The research shall develop:

- Guidelines on the interaction between pier and contraction scour.
- Guidelines for determining total scour potential based on studies conducted as part of this project and others.
- Methods for drawing 2D and 3D scour profiles.
- Model guidelines for state departments of transportation (DOTs) and others to implement the findings.

All proposed methods and guidelines must be rational and properly structured, well documented, and convincing for the Federal Highway Administration (FHWA), state DOTs, and practitioners. This study should be evaluated by a few state DOTs to ensure it is comprehensive, logical, and practical. The outcome shall be published in the form of one or multiple (if needed) technical manual(s) that could be utilized by FHWA and state DOTs.
FHWA recommends designing and testing pavements for friction in Technical Advisories TA 5040.36 and TA 5040.38. High friction surface treatment (HFST) is a widely used countermeasure for roadways needing additional friction due to high friction demand (curves and intersections). On top of these pavements, even HFST, pavement markings are typically placed without any friction requirements. The Manual on Uniform Traffic Control Devices (MUTCD) notes, “Consideration should be given to selecting pavement marking materials that will minimize … loss of traction for road users…” But AASHTO standards for typical pavement marking materials do not currently include a friction test or requirement. Retro-reflectivity and wet-reflectivity have been the recent focus in U.S. pavement marking specifications. Even recent MUTCD proposed changes address retro-reflectivity but not friction. Europe has already performed some research related to pavement marking friction. European standards include differential friction requirements and friction requirements for pavement marking materials. They have found that friction and retro-reflectivity often can result in a trade-off in developing pavement marking materials. With the United States focus solely on retro-reflectivity, friction of pavement markings can ultimately be traded for higher visibility.

Friction and changes or differentials in friction can be a safety concern for two-wheeled vehicles (motorcyclists or bicyclists). The use of words and symbols, particularly as guides on complex roadways, has been found to have a positive influence on guidelines for drivers. Large pavement markings also have the potential to reduce wrong-way crashes. But the friction levels for these larger pavement markings could be a major detriment if not specified, tested, and verified for the friction demand of users.

Some state departments of transportation (DOTs) are aware of and working on the pavement marking friction issue. Minnesota DOT is testing high friction pavement markings on roundabouts. Florida DOT has standard requirements for pavement friction for specialized pavement marking materials and it recently installed pavement guidance shields on I-95 using special high friction pavement marking materials. While Europe has used a British Pendulum Test value (BPN) for setting friction levels, Florida has identified concerns with this value and is using different equipment for testing friction (dynamic friction tester (DFT)). Additional research is needed to address what friction levels should be required for pavement markings and the best method to test the friction. The requirements could be implemented by adding to AASHTO standards for pavement markings and the AASHTO National Transportation Product Evaluation Program (NTPEP) requirements for pavement marking materials.

The objective of this research is to evaluate existing friction testing methods for pavement marking materials and provide recommendations for AASHTO standards for pavement marking material testing and specification standards. The research will entail (1) gather existing domestic and international research related to pavement marking friction, (2) contact state agencies to identify any additional current experience with friction and pavement markings, (3) identify gaps in the material and address or document research needs (i.e., dry and wet weather marking friction), (4) develop a testing plan to test and assess different types of friction testing equipment applicable to pavement markings, (5) develop a testing plan to test different available pavement marking materials nationwide to use as a baseline for friction specifications, and (6) perform the testing plans noted in (4) and (5), and create draft standard language in AASHTO format or develop recommended modifications to existing AASHTO standards to address friction requirements for pavement markings.
**Performance-Based Tests for Asphalt Emulsion Treatments as Part of Agency Acceptance and Incentive Programs**

Research Field: Materials and Construction  
Source: Rhode Island Department of Transportation  
Allocation: $400,000  
NCHRP Staff: Amir N. Hanna

AASHTO, the AASHTO Committee on Materials and Pavements (COMP), and the AASHTO TSP2 Emulsion Task Force (ETF) have worked together to develop agency-approved materials specifications and design practices for a wide range of asphalt emulsions and asphalt emulsion-based treatments. But tests (laboratory and field) that could be used to determine the in-service performance and expected life cycle of these treatments applied according to these new AASHTO-approved material specifications and design practices are largely unavailable.

Many state departments of transportation (DOTs) have ready access to hot mix asphalt (HMA) tests and specifications that can be used to measure key characteristics that have been empirically shown to correlate with field performance. These agencies have also used these same tests and specifications to develop incentives/disincentives programs for the contractor. Examples of the types of HMA tests that have been used in DOT-based incentive/disincentive programs are lab molded density, in-place density, asphalt content, and gradation. Similar types of performance-based tests and specifications need to be determined for asphalt emulsion treatments to allow for these same types of incentive/disincentive programs to be developed by agencies for use with the emulsion contracting community. The various asphalt emulsion treatments include chip seal (MP 27, PP 82), microsurfacing (MP 28, PP 83), fog seal (MP 33, PP 88), bonded surface treatment (MP 44), cold recycled mixtures (MP 31), foam asphalt stabilization (PP 38), sand seal (MP 34, PP 90), scrub seal (MP 43, PP 91), slurry seal (MP 32, PP 87), tack coat (MP 36, PP 93), emulsified asphalt (M 140), cationic-emulsified asphalt (M 208), and polymer-modified cationic-emulsified asphalt (M 316).

This research would lead to the identification and/or development of various tests and specification limits related to the field performance of the selected asphalt emulsion-based treatments. In turn, this will allow DOTs to develop performance-related acceptance criteria in conjunction with their quality assurance (QA) programs. Furthermore, incentive/disincentive programs could be developed for use with the emulsion contracting community and could lead to even longer in-service life for these treatments.

**Project 10-135**

*Removing Barriers to Sharing Subsurface Utility Engineering (SUE) and Digital As-Built Data (DAB) Between Utility Companies and State Departments of Transportation (DOTs)*

Research Field: Materials and Construction  
Source: AASHTO Committee on Right of Way, Utilities, and Outdoor Advertising Control  
Allocation: $600,000  
NCHRP Staff: Christopher T. McKenney

State departments of transportation (DOT) and utility companies traditionally have not shared data due to (1) limited technology allowing data captured on paper and stored in CAD to be easily exchanged, and (2) the risks and concerns about the liability of sharing data that may not be accurate and/or may change in the future. New geospatial technologies are being implemented by state DOTs and utility companies for internal purposes, but they have not been deployed to exchange data. Additionally, utility companies have concerns about controlling access to their location data related to security and exposure to competitors.

Significant research has been conducted to document and quantify the negative impact and cost from utility conflicts and the lack of data sharing between utilities and DOTs and strategies. Much of this research was performed under the Second Strategic Highway Research Program (SHRP2) R15B, “Identification of Utility
Conflicts and Solutions,” which examined best practices and tools to mitigate these costs and conflicts. Additional research identified through NCHRP Project 20-07 Task 418, “An Impact and Value Analysis of Requiring Geospatial Locations for Utility Installation As-Builts,” published a report that quantified the benefits of sharing geospatial utility as-builts and the barriers to collecting this data. This research proposes to focus on the utility perspective to define the benefits that utility companies will receive and overcome their perceived risks and liability.

The objective of this research is to provide a framework for implementing a mutually beneficial mechanism to exchange geospatial asset location data between utility companies and state DOTs including subsurface utility engineering (SUE) data and digital as-built (DAB) data. To accomplish the research objective, a research plan for each issue in priority order should be developed and approved, which should include:

- Defining data collected by DOTs and utility companies that could potentially be exchanged including SUE data in accordance with American Society for Civil Engineers (ASCE) 38 and DAB data in accordance with ASCE 75;
- Defining benefits and value proposition of exchanging SUE and DAB data from the utility’s perspective;
- Defining the barriers and risks of exchanging SUE and DAB data from the utility’s perspective;
- Identifying and describing successful real-world data exchange programs within DOTs including the benefits and methods to overcome barriers and risks;
- Identifying technologies to automate the capture and exchange of SUE and DAB data including GPS, mobile and cloud geographic information systems (GIS), drones, and light detection and ranging (LiDAR);
- Documenting relevant data protection measures DOTs have employed to reduce risks to utility company data, including risks utility companies perceive related to infrastructure security and risks perceived that relate to intellectual property or competitive advantage;
- Defining the legal, regulatory, and legislative requirements for implementing a data exchange program;
- Conducting a pilot project to demonstrate the exchange of SUE and DAB data including an assessment of benefits and risks from the utility’s perspective;
- Creating guidelines for DOTs and utilities to implement a data exchange program design process and can cause further delays if unknown utilities are discovered during construction.

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**Project 10-136**

**Right-of-Way and Utility Risk Identification and Management**

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<td>Christopher T. McKenney</td>
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Right-of-way (ROW) and utilities are recurring risk factors for highway projects that could delay the capability of state departments of transportation (DOTs) to deliver projects on time and within budget. Utility facility locations during construction is frequently considered a critical risk factor, but other important risk factors are frequently underestimated, including coordination of infrastructure project phasing with utility work schedules; constructability and structural characteristics and performance (e.g., soil and bedding characteristics, material properties, strength, resilience); traffic control, grading phasing, ROW clearing, signalization phasing, utility shared facility coordination, damage prevention, and worker safety; abandoned utilities, field inspection, verification, and production of as-built records; and utility relocation cost estimates and management.

The risk management process includes five iterative steps: risk identification, risk assessment, risk mitigation, risk allocation, and risk monitoring and control. Risk registers are commonly used to manage risk, although
other risk management tools are used. A key component of a risk register is a matrix that combines the effect of probability of events and impact if the event happens. *NCHRP Report 658: Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Project Costs* defined risk management as the “sequence of analysis and management activities focused on creating a project-specific response to the inherent risks of developing a new capital facility.”

However, the topics of risks and risk management in areas relating to utilities and ROW has been limited. For example, FHWA developed the **Risk Management Register** spreadsheet tool that includes a suggested list of risks for risk management purposes, but the list only includes unidentified utility impacts under the construction functional area. The FHWA risk register spreadsheet tool includes five ROW risks, but state DOTs have indicated that the list of ROW risks should be extended, relating to the (1) identification and documentation of prior rights and prescriptive right claims, (2) identification of the party who has what property interests within the ROW or the accuracy (spatial and nonspatial) of the information, and (3) identification and documentation of prior rights and prescriptive right claims.

The purpose of the research is to (1) develop and evaluate methodologies to conduct qualitative and quantitative ROW and utility risk assessments during all phases of transportation project delivery and (2) develop guidelines compatible with standard risk management tools and strategies currently in use at state DOTs. To accomplish these objectives, the research should complete the following activities:

- Conduct a review of risk management tools and methods state DOTs use to address and manage ROW and utility risks at the project level;
- Conduct a national survey to prepare a ranked list of project-level ROW risk factors;
- Develop and test methods to evaluate and quantify risks, individually and per category, including a holistic approach during each project delivery phase;
- Examine potential differences between design-bid-build, design-build, and other project delivery methods;
- Propose strategies to mitigate, allocate, and monitor ROW and utility risks throughout project delivery; and
- Develop clash analysis tolerances for various utility features as a guideline for use during utility impact analysis (UIA) activities.

### Project 10-137
*Specifications for New Construction and Rehabilitation of Movable Bridges*

**Research Field:** Materials and Construction  
**Source:** Indiana Department of Transportation  
**Allocation:** $500,000  
**NCHRP Staff:** Ahmad Abu-Hawash

The life cycle costs of movable bridges are highly influenced by construction quality, which is a function of the adequacy of the technical specifications by which a project is executed. Unfortunately, there are no national standards providing technical specifications specifically for movable bridge construction. The *AASHTO Standard Specifications for Movable Highway Bridges*, last updated in 1988, contained limited information on construction, primarily related to machinery. This document was replaced by the *AASHTO LRFD Movable Highway Bridge Design Specifications* in 2000, which does not contain specifications for construction. Therefore, no current AASHTO document addresses movable bridge construction specifically. Significant gaps exist in current AASHTO specifications related to steel fabrication and erection specific to the unique aspects of movable bridges, such as structural steel fabrication alignment and machining tolerances. Machinery and electrical systems for movable bridges are not addressed in the current AASHTO construction specifications, although many aspects of this work are covered in detail in related industrial standards, albeit not as it
specifically relates to movable bridges. All movable bridge owners would benefit from a comprehensive national document that fills the current gaps for movable bridge construction.

This research proposes development of an AASHTO specification for construction of movable bridges, applicable to new bridge construction and repair/rehabilitation. This new document would fill an existing void in the AASHTO specifications and provide construction specifications for the common types of movable bridges and their structural, mechanical, and electrical components.

Examples of items not covered in the current AASHTO specifications include:

- Counterweight construction and span balancing;
- Dimensional tolerances for steel fabrication for movable bridges, particularly at the interface with machinery, joints, and movable bridge deck systems (open steel grid, Exodermic®, etc.);
- Electrical fabrication and construction, including power, controls, and communications;
- Mechanical fabrication and construction, including alignment; and
- Startup, testing, and commissioning procedures for movable bridges.

Additional reference documents are available that provide requirements for construction of mechanical, hydraulic, and electrical power and control systems for industrial application. These are often referenced as a basis for movable bridge construction. Example reference documents include publications from the National Fire Protection Association (e.g., NFPA 70 National Electric Code), American Gear Manufacturers Association, and the National Fluid Power Association.

**Project 10-138**

**Strategies for Earlier, More Effective Right-of-Way Engineering Involvement in Project Delivery**

Research Field: Materials and Construction

Source: AASHTO Committee on Right of Way, Utilities, and Outdoor Advertising Control

Allocation: $450,000

NCHRP Staff: Christopher T. McKenney

Right-of-way engineering (RWE) teams at state departments of transportation (DOTs) verify existing road rights-of-way (ROW) and easements, confirm land ownership and related encumbrances, validate proposed ROW acquisitions, and review construction designs for a given project. At state DOTs without formally established ROW engineering teams, the work is completed by teams that fulfill a similar responsibility.

With proper scheduling and time allocations, this work occurs in a timely manner, encourages public involvement/National Environmental Policy Act (NEPA) approvals, fosters a smooth process for the ROW appraisal and acquisition groups, and facilitates the completion of the project’s design and construction phases. Unfortunately, many state DOTs delay RWE involvement in the design process. Frequently, ROW acquisitions occur on the critical path, considerably raising the level of risk to potentially affect project delivery and construction.

Delays in RWE involvement may trigger numerous setbacks due to ROW-related information: plans may be incomplete or inaccurate, designs may change, and property owners may be uncooperative. These factors do not necessarily change a deadline, so appraisal and acquisition groups are rushed to confirm property details, negotiate with property owners, and deal with design changes as they occur. As a result, the DOT is rushed to clear the ROW which may require paying more for needed land, missing deadlines, and/or shifting scopes of work. Beyond the DOT, project delay impacts to the community include traffic congestion, possible road closure/structure failure, and political involvement.
The availability of conducted research that specifically addresses RWE needs is limited compared to other transportation areas (e.g., pavements, materials, traffic, safety, or planning). Therefore, research is needed to document current RWE review methods around the country and develop strategies and proposed standards for the effective involvement of RWE teams throughout the project delivery process. At a minimum, the research should:

- Identify and evaluate existing ROW review methods used by DOTs across the country;
- Compare RWE review start times versus project delays and impacts to schedules/budgets;
- Identify best practices for RWE review schedules and allocations; and
- Identify best practices for RWE review funding.

Project 10-139
Update the AASHTO Pavement Management Guide

Research Field: Materials and Construction
Source: AASHTO Committee on Materials and Pavements
Allocation: $500,000
NCHRP Staff: Amir N. Hanna

The second edition of the AASHTO Pavement Management Guide was published in 2012. Since its publication there have been many changes in pavement management practices. The 2021 update to the FHWA’s Pavement Management Roadmap identified significant interest in developing more step-by-step assistance on many topics to support the practitioners’ training demands. In addition to updating existing topics, potential additions to the new Pavement Management Guide might include (1) enhancing data collection activities (contracting practices, using traffic speed deflectometer (TSD) data to define network structural condition, using ground penetrating radar, establishing precision and bias statements, and improving data quality); (2) managing large datasets effectively (strategies for archiving data and using artificial intelligence, machine learning, and other tools to analyze data); (3) developing effective performance models (evaluating the reasonableness and reliability of models and updating models with new information such as structural data, risk, and resilience factors); (4) improving project and treatment selection (incorporating new factors into the models, such as structural data, sustainability, equity, and resilience; incorporating pre-treatment condition into treatment selection; and improving the match between planned and programmed projects); and (4) using pavement management information to drive decisions (setting targets; developing asset management plans; and presenting analysis results effectively.)

This research will address these demands through an update to the AASHTO Pavement Management Guide in an online, searchable document that can be revised as new research and technical materials become available. The research objectives will be accomplished through the several activities: (1) identify new content to be addressed in the updated Pavement Management Guide; (2) present an approach for modifying or replacing the 2012 Pavement Management Guide, including suggestions for whether a print version will be published; (3) develop the material for the new Guide using available resources and case examples; (4) identify other resources that could be incorporated into an online version of the document, such as videos, training materials; (5) develop an online version of the updated AASHTO Pavement Management Guide with search features and hyperlinks to the Pavement Management Roadmap; and (6) conduct a book club to promote the completed Guide.

Project 10-140
Managing Transportation Rights-of-Way with a Utility Awareness

Research Field: Materials and Construction
Source: AASHTO Committee on Right of Way, Utilities, and Outdoor Advertising Control
Allocation: $500,000
State departments of transportation (DOT) have traditionally been tasked, as part of their stewardship of the right-of-way (ROW), to accommodate utility infrastructure. With deregulation of communication, Dig-Once guidelines, broadband initiatives, and other emerging trends, there is more demand from utilities to occupy the ROW than ever before. State DOTs must establish a new approach to managing ROW to allow for reasonable and efficient accommodation of these infrastructures. This is especially important as Interstate and freeway ROW is being opened to accommodate utilities that have been prohibited in the past. State transportation agencies (STA) are unable to appropriately review, process, and inspect the utility installations with the resources available as it relates to managing project costs, schedules, and associated risks. Most STAs have recognized that they do not have good records of what or where utilities are installed. This is problematic for any appropriate management of the ROW. This is further complicated as it is difficult to obtain record drawings of new installations leaving a void in knowing what is installed in the ROW.

ROW and utilities are two of the most common reasons for delays in highway projects. Accommodating utility facilities within the ROW has long been recognized to be in the public interest. However, because utility facilities are not considered a highway purpose (with some exceptions), a practical challenge is how to reconcile this public interest with the reality of what STAs have the authority to do for managing the ROW. A holistic ROW management plan can assist in the development and delivery of infrastructure programs that incorporates permitting, utility coordinators, ROW engineering, ROW acquisition, broadband coordinators, construction inspectors, and intelligent transportation systems (ITS) departments.

The utility industry is changing rapidly, but current ROW and utility management practices at STA still follow a model that reflects historical practices when there were only a few highly regulated utility facilities within the ROW. Identifying ROW and utility accommodation needs is an integral component of the project delivery process. Providing state DOTs and STAs with a compendium of strategies to present to leadership and state legislators that would exhibit the need for appropriate expectations, processes, and resources is important, too.

The purpose of the research is to develop (1) new or enhanced strategies to proactively manage transportation ROW with a utility awareness, (2) business practices needed to accommodate utility infrastructure in the ROW, and (3) an implementation plan for state DOTs and STAs for building a ROW management plan with a utility awareness.

**Project 12-126**

*Design Method for High-Load Multi-Rotational Disc Bearings for Bridges*

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<td>NCHRP Staff:</td>
<td>Ahmad Abu-Hawash</td>
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Bearings are a relatively small component of bridge structures, but they are critical for safety and proper long-term performance. The bearings must support the weight of a bridge as well as adjust for thermal expansion and contraction, traffic loads, and extreme events such as earthquakes and high winds. Bearing failures can result in hazards to the traveling public, traffic delays, and costly damage to the bridge. Therefore, accurate bearing design is critical to ensure the best and most economical bearing will be specified.

The *AASHTO LRFD Bridge Design Specifications* (BDS) currently contain minimal design criteria for disc bearings. The BDS requirements are predominately based on NCHRP Project 10-2A, “High-Load Multi-Rotational Bearings” initiated in 1986 and published in 1999.
Due to the limited design specifications, bridge designers are dependent on disc bearing manufacturers’ unique in-house designs. This uncertainty means that disc bearing designs may not be finalized until well into the construction of a bridge. At such a late stage, field changes to accommodate the bearings are costly and disruptive. Not only can incomplete design specifications result in substantial interruption during construction, they leave the owner uncertain about the long-term performance of the bearings. There is currently limited means to determine how existing bearings perform over time, especially with increasing traffic volume cycles and loadings. A predominant bearing manufacturer estimated that 15,000 bridges in North America currently use their disc bearings. Hence, the impact of flawed long-term performance could be significant.

The objective of this research is to develop design procedures and acceptance testing methods for high-load multi-rotational disc bearings.

The final products of this project will be (1) guidelines for all aspects of designing disc bearings, (2) guidelines for the acceptance criteria for owners and designers to specify when purchasing bearings, and (3) ballot-ready language for AASHTO to consider related to *AASHTO LRFD BDS* regarding disc bearing design and acceptance testing.

**Project 12-127**  
**Load Rating and Posting of Long-Span Bridges**

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<td>NCHRP Staff:</td>
<td>Ahmad Abu-Hawash</td>
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Bridge engineers typically restrict traffic by implementing a load restriction on a structure. This is usually embodied by a posted weight limit sign adjacent to the structure. The weight limit is usually based on a state’s legal loads evaluated at the operating level (i.e., the maximum load a bridge can safely support), and can range from 3 tons gross vehicle weight (GVW) up to the maximum legal load for a state, typically 40 tons GVW. Furthermore, a weight limit sign also can indicate limits for different vehicle configurations.

Although current AASHTO specifications provide sufficient direction for bridges with span lengths ≤ 200 feet, they are vague in the evaluation of structures with span lengths > 200 feet and they lack a complete and consistent approach to evaluating live loads, load ratings, and postings.

Another topic on the horizon is the use of truck platooning via connected and autonomous vehicles. Tightly spaced heavy trucks will increase live load effects above current standards. Long span bridges will be at increased risk if not evaluated properly. While long span bridges may commonly get special rigorous engineering and analysis in the design phase, this does not mean there are practical methods available for limiting loads in service when deterioration or other conditions warrant. Furthermore, the current load rating specifications absolutely do not address spans longer than 300 feet, with vague language addressing spans between 200 and 300 feet. One of the top hoped-for outcomes of this research is a specification that helps owners post long span bridges of lane load controls, which is more likely the longer the span. For instance, how would lane load be modelled for a long span bridge to determine an allowable load capacity, and possible subsequent posting?

The objective of this research is to develop a consistent and clear method to analyze live load force effects and develop load rating and load posting methods for structures with span lengths > 200 feet in length.

A possible scope may include:

- Evaluation and comparison of (1) varying force effects, (2) load ratings, and (3) posting methods caused by applying various live load configurations.
- Developing consistent definitions for (1) span length and/or influence length, (2) truck train, (3) study lane, and (4) adjacent lane(s).
- Developing method to account for reduced adjacent lane force effect when bridge needs to be posted.
- Developing method to incorporate state specific legal vehicles and routine permit vehicles.
- Proposing modifications to AASHTO bridge evaluation manuals and bridge design specifications.

**Project 17-123**

*Light, Medium, and Heavy Rail and Roadway Interface Safety Performance Functions and Crash Modification Factors Development*

Research Field: Traffic  
Source: AASHTO Committee on Rail Council  
Allocation: $500,000  
NCHRP Staff: Zuxuan Deng

The *Highway Safety Manual* (HSM) supplies safety performance functions (SPFs) for several types of roadways and intersections. The CMF Clearinghouse (CMFClearinghouse.org) supplies crash modification factors (CMFs) that may be applied to determine the effect of various safety countermeasure implementations and activities. One limitation of the HSM is the lack of safety models for highway-rail envelopes (HREs) or consideration of HREs in existing SPFs adjustment factors. For this research problem statement, HRE describes a group of road and rail crossings that include the common highway-rail grade crossing (HRGC) and those interfaces where the railroad track (including light rail transit (LRT) lines) is within and share the travel way with other motorized vehicles or non-motorized users, i.e., pedestrians or bicyclists. HREs are unique facilities that involve two or more transportation modes.

There are CMFs contained in the CMF Clearinghouse that cover a variety of safety countermeasures for HRGC. They cover the traditional safety measures, such as signs, bells, gates, lights, and a limited selection of LRT applications, but other CMFs are needed to address gaps for commonly used HRE safety countermeasures. There is a need to have SPFs and additional CMFs to address light rail (transit), medium rail (transit and freight), and heavy rail (transit and freight) HREs. Traditionally researchers have considered safety issues that exist at locations where the rail and the road cross. Complicating the safety issue is that the rail may share the roadway space (e.g., medium/heavy rail within industrial settings and LRT like streetcars), operate parallel along one side of a roadway (at relatively close proximity to the roadway, often in a shared right-of-way), or within the median of a roadway, significantly complicating the operation of the rail and the roadway. These parallel and shared orientations create unique safety concerns that are not well documented and do not have documented CMFs for safety countermeasures that have been implemented.

The objective of this research is to develop SPFs and CMFs for all road users (including non-motorized users) that can be used to estimate the severity and number of crashes likely to occur at HREs, under a variety of rural and urban contexts, to include light, medium, and heavy rail HREs. The results of this research should enable transportation agencies to quantify the safety effects of HREs design features and safety performance of implementing countermeasures at a particular location so that safety performance can be compared to alternative configurations. Being able to consider safety effects of these interfaces along with other predicted crashes would aid agencies in finding the safety effectiveness of existing and proposed HREs. CMFs for commonly used safety treatments, but not currently documented within the CMF Clearinghouse, could be developed.

**Project 17-124**

*Effectiveness of Speed Reduction in Work Zones.*

Research Field: Traffic
 According to the Work Zone Management Program, FHWA statistics, there were 774 fatal crashes in the work zones in 2020, up from 765 in 2019 (https://ops.fhwa.dot.gov/wz/resources/facts_stats.htm). Speeding was determined to be a factor in 37% of fatal crashes in the work zones in 2020, up from 32% in 2019.

Caltrans has been using the Non-Standard Special Provision 12-4.02C(12) since 2010 that requires the contractor to implement Construction Work Zone Speed Limit Reduction. This work requires installation of temporary construction signs and portable changeable message signs equipped with the speed sensing radars. The addition cost of the materials and labor is justified if the implementation is effective.

The purpose of the research would be of the motorists’ compliance with the speed limit reduction and consequent reduction of the rates and severity of work zone crashes.

Many States have been lowering speed limits in construction work zones to reduce fatal and injury crashes. The objective of this research project is to confirm if the current effort to lower speed limits in construction work zones is effective in reducing the rate and severity of accidents and injuries to workers and drivers. If not, the research will look at ways to supplement the reduced speed limits through enforcement and ITS solutions.

Active Work Zones are more prevalent at night, in the lane closures next to the live traffic. The rates of accidents in Construction Zones have been on the rise, resulting in fatalities and severe injuries, in addition to the infrastructure damage and delays to the projects. The requirement to implement Speed Reduction in Construction Zones has become a standard in the majority on construction projects. The perceived benefit is the reduction in severe injury collisions.

Project 17-125
Incorporating the Safe System Approach into Road Safety Audits

Research Field: Traffic
Source: Arkansas Department of Transportation
Allocation: $425,000
NCHRP Staff: Jennifer L. Weeks

As the United States begins to engage in the Safe System approach (SSA) to road safety, opportunities exist to update current tools. The Road Safety Audit (RSA), known as the Road Safety Assessment in some agencies, is one such tool. As safety practitioners become familiar with the concepts and principles of SSA, there is a need for practical and implementable recommendations to apply these concepts and principles to the key functions of transportation agencies and individual practitioners. RSAs are a tool commonly used in jurisdictions at all levels and present an opportunity for increasing awareness and use of the SSA.

The objective of this research is to develop a guide with appropriate supplemental materials providing clear and actionable strategies to effectively integrate Safe System principles into the road safety audit process. The guide should include recommended procedures, methods, and tools for safety audit practitioners on how to assess the design and operations of new and existing facilities from a SSA perspective. This would include incorporating speed management, road user separation, human factors, and the principles of road user equity in design. The research will develop guidelines for transportation agencies that can be used for the planning, design, construction, and operations of road systems.

Searching for opportunities to reverse the upward trend in traffic fatalities, many states are interested in moving toward SSA and have been searching for practical ways to implement SSA principles. Many strides have been
made in the field of transportation safety since the original RSA concept was developed and implemented. This research will help safety professionals more fully understand the relationship between SSA and RSA process and develop recommendations for fatality reduction programs and projects.

**Project 17-126**


Research Field: Traffic  
Source: Arkansas Department of Transportation  
Allocation: $750,000  
NCHRP Staff: Roberto Barcena

In 2010, AASHTO published the first edition of the *Highway Safety Manual* (HSM). HSM Part C includes methods to predict the safety performance of new facilities, assess the safety performance of existing facilities, and estimate the expected effectiveness of proposed improvements to existing facilities.

To further expand the intersection types addressed in future editions of the HSM (i.e., HSM3), crash prediction models (CPMs) could be developed for additional intersection configurations and traffic control types that are not addressed in the first edition of the HSM and were not developed for HSM2 as part of NCHRP Project 17-68.

The objective of this research is to develop CPMs for consideration to include in a future edition of the HSM that are consistent with existing methods in HSM Part C and comprehensive in their ability to address a range of intersection configurations and traffic control types in rural and urban areas. The new CPMs must be developed so that comparisons can be made between the safety performance of intersection types included in the HSM and the intersection types that will be addressed in this research. The research should include a pilot test activity before finalizing the models to help demonstrate the use of the models, applicability to practical use cases encountered by transportation agencies, implementation support needed, and needed refinements that can be made before the research is complete.

Intersection configurations and traffic control types for which CPMs could be developed may include:

- Intersections with frontage roads
- Restricted crossing U-turn intersections (RCUTs)
- Median U-turn intersections (MCUTs)
- Jughandle intersections
- Displaced left-turn intersections
- Continuous green tee intersections
- Intersections with yield or no control
- Rural five-leg intersections
- Urban and suburban five-leg intersections with minor-road stop control
- Six-or-more-leg intersections
- Diverging-diamond ramp terminals

**Project 17-127**


Research Field: Traffic  
Source: Arkansas Department of Transportation  
Allocation: $500,000  
NCHRP Staff: Zuxuan Deng
The **Highway Safety Manual (HSM)** is a guidance document for incorporating quantitative safety analysis in highway transportation project planning and development processes. Many procedures contained in the HSM are complex and challenging for the average practitioner to apply. Given the complexities of the HSM, it may not be used to its full potential or, in some cases, misapplied by state and local highway agencies. Under NCHRP Project 17-50, “Lead States Initiative for Implementing the Highway Safety Manual,” a **Highway Safety Manual User Guide** was developed for the 2010 AASHTO HSM, first edition. The NCHRP Project 17-50 guide gave the HSM user a perspective on how to use the HSM. It further addressed a limited set of potential HSM applications, emphasizing how to use the HSM within a safety analysis. However, it has become dated, especially considering the forthcoming HSM section edition (HSM-2). The examples supplied lack detail to address the complex computations and complexities presented in the HSM-2. A vigorous in-depth practitioner guide is proposed to enhance safety professionals’ abilities in program management, system planning, project planning, preliminary engineering, final design, construction, maintenance, and operations to address roadway safety for all users and all routes.

The objective of this research is to develop a practitioner’s guide on the use of the HSM-2 for system planning, project planning, preliminary engineering, final design, construction, maintenance, and operations applications by identifying proper methods and applications and illustrating them with case studies. The guide should supply practitioners with an understanding of HSM procedures, how to apply the findings, and how to use complex models and multilevel steps to conduct a proper HSM safety analysis and the decision-making process. Discussions within the text should supply practitioners with guidance on interpreting the results, limitations of specific models, and how to decide the proper use and application of model results, along with an understanding of how to apply the results as part of a safety management program. The guide should cover aspects such as, but not limited to: (1) uses of HSM for a broad variety of planning and engineering applications (including different stages, scales, complexities, and system configurations); (2) uses for parts of the HSM (e.g., steps in the safety management process, appropriate use of safety performance functions, adjustment factors, and application of crash modification factors); (3) uses of the HSM in scenario planning or alternative analysis; (4) coordinate use of the HSM with other planning, design, and operations functions (e.g., environmental decisions, capacity analysis, and operations analysis), along with coordination with associated manuals and guides; (5) uses of the HSM in the decision-making process (e.g., network screening, diagnosis, countermeasure selection, economic appraisal of selection, prioritizing projects, and safety effectiveness evaluation); (6) how to consider and incorporate HSM analysis for conditions not implicitly covered by the HSM; (7) uses of the HSM to limit liability and other legal implications of design and operations decisions; and (8) uses of the HSM with associated spreadsheets and freely available software platforms for analyses.

**Project 17-128**

**Reducing Adverse Driving Behaviors in Work Zones**

Research Field: Traffic  
Source: Federal Highway Administration (FHWA)  
Allocation: $600,000  
NCHRP Staff: Roberto Barcena

In 2020, 857 fatalities and 44,000 injuries occurred in work zones across the country. Many studies have shown that crash risks increase in work zones and that most crashes (including those in work zones) are attributable to driver error. The presence of enforcement is known to reduce adverse driving behaviors (excessive speeding, tailgating, aggressive driving, distracted driving, etc.), but its effect is limited temporally and spatially. In addition, staffing and funding constraints limit the availability of enforcement in some locations. Technologies are available to help supplement enforcement efforts and provide real-time warnings of changing conditions to motorists, but their effect on adverse driving behaviors has not been fully investigated to date.

Multiple education and outreach programs designed to discourage adverse behaviors and encourage better driving behavior have been developed, but it is not clear how best to tailor them to the specific situations
typically encountered in work zones. Research is needed to aid state departments of transportation and other transportation agencies in mitigating crashes that occur in work zones due to adverse behaviors.

The objectives of this research are to:
- Identify traditional and innovative strategies/technologies that can counter adverse driving behaviors unique to work zones,
- Evaluate the effectiveness of those strategies/technologies, and
- Develop guidelines and tools to support their effective implementation by transportation professionals.

Direction from the AASHTO Committee on Research & Innovation: Panel needs to verify the definition of behavioral.

**Project 17-129**

*Safety Performance of Complex Interchanges*

Research Field: Traffic  
Source: California Department of Transportation  
Allocation: $700,000  
NCHRP Staff: Jennifer L. Weeks

Many service interchanges include custom designs that do not fit into the traditional interchange definitions in the AASHTO Green Book, which makes it challenging to predict and compare the relative predicted crash frequency of different interchange forms. Complex interchanges involving isolated ramps, direct high-occupancy vehicle (HOV) connections, direct connections to frontage roads, ramp termini closely spaced or clustered with cross street/frontage road intersections, ramps connecting to nearby developments, and/or other customizations are becoming more common. The *Highway Safety Manual* (HSM) provides crash prediction for interchange elements such as simple ramps and basic ramp termini configurations, but does not provide a comprehensive crash prediction methodology that can be applied to the large number of interchanges that are not typical basic design.

Research is needed to identify and quantify the relationship between each conflict point type at service interchanges on the overall crash frequency of the interchange. The research should generate a methodology consistent with the HSM to develop customized safety performance functions (SPFs) for complex or new interchange designs, including those not identified in the AASHTO Green Book or HSM.

The product of the research will be a series of crash prediction models for the various interchange elements, implementable within the mechanics of the HSM. This is relevant to the AASHTO HSM Committee as it will contribute to future updates to the HSM.

Gaps remain within the HSM predictive methodology regarding applications to the various interchange configurations being used. Research should generate a building-block approach, incorporating the fundamentals of interchange planning and design, and may provide more timely direction than the traditional approach of developing an independent SPF for each form. As interchange forms are continuously expanded and modified to address safety concerns and other needs, agencies have limited documentation on how to quantitatively assess the safety effects of different interchange configurations and major changes (such as converting or adding ramps to a median high occupancy/toll (HOT) access to an existing interchange crossroad or ramps connecting multiple roads).
A recent survey conducted by AASHTO concluded there is an uncertainty of fly ash (specifically Class F) availability. Indications of changes in composition and incorporation of alternative supplementary cementitious materials (SCM) (e.g., natural pozzolans, reclaimed / harvested ashes, blended ashes, calcined clays, waste glass, bottom ashes, etc.) in concrete is increasing. Within the next 5 years, there may be a pressing need to make use of alternative SCM to make durable and sustainable concrete for different highway applications.

NCHRP Project 10-104, “Recommendations for Revision of AASHTO M 295 Standard Specification to Include Marginal and Unconventional Source Coal Fly Ashes,” is investigating ways to improve the AASHTO M 295 (ASTM C618) specifications by developing and incorporating effective tests for measuring SCM reactivity, addressing air void issues related to unburned carbon interaction, and monitoring uniformity. The improvement to AASHTO M 295 (ASTM C618) is expected to improve the pass/fail criteria and promote effective utilization of fly ashes and natural pozzolans. A thorough evaluation is needed to research effects of alternative SCM’s on key fresh concrete properties (water demand / workability), hardened properties, durability performances (e.g., alkali-silica reactivity (ASR), corrosion, freeze-thaw (FT), shrinkage etc.) since these elements were not included in the scope of work for NCHRP Project 10-104.

Additionally, AASHTO M 295, AASHTO R 80 and ASTM C1778 do not address the effectiveness of alternative SCMs to mitigate ASR. Chloride-induced corrosion of reinforcing steel, damage caused by F/T cycles, and joint deterioration due to formation of oxychloride are primary deterioration processes responsible for premature deterioration of concrete in bridge decks, pavements, and other applications. The transport properties of concrete are not properly considered in the current tests for chloride/fluid transport. Moreover, these tests require laborious sample conditioning and are time-consuming. Therefore, the tests that capture the pore connectivity as a function of microstructure development should be considered as a reliable way to access corrosion and F/T performance evaluation of concrete mixes using alternative SCMs.

Many state departments of transportation (DOTs) and commercial laboratories have recently implemented resistivity-based test methods for durability assessment and quality assurance purposes. However, these tests do not adequately capture the influence of pore solution chemistry (PSC) on resistivity measurements. The formation factor has shown to be a better descriptor to characterize the microstructure and assess the transport properties of concrete mixes. A key benefit of using the formation factor toward specification is that an easy resistivity measurement in a field or lab can estimate service life using service life models based on formation factor/transport properties relationships.

Therefore, research is needed to develop a work plan to: (1) investigate the effects of alternative SCMs on key fresh, hardened and durability properties; (2) determine properties of a concrete mixture critical to its success based on intended application and exposure conditions; (3) assess and recommend appropriate test methods for the defined properties, along with valid tolerances and pass/fail limits; and (4) develop tools (e.g., software,
With recent labor and material shortages, state departments of transportation (DOTs) are facing difficulty accurately budgeting for projects. This is compounded by the impacts of high inflation. In this unstable market, the cost for materials and labor is volatile and rising rapidly, and contractors must include this risk component in their bids. Fluctuating prices of certain bid items, such as asphalt and fuel, have historically been accommodated through escalation clauses, which can mitigate the dynamic price environment. Through this method, risk is reduced for contractors, which in turn translates into cost savings for the state DOT. It is also recognized that price escalation clauses are extremely limited in practice, there is a lack of consistent indexing for most construction materials and manufactured products (e.g., lane striping), and existing fuel and asphalt binder adjustment factors used by many DOTs are not consistently updated.

With the advancement of new construction materials, equipment, and technologies, a national research effort would provide DOTs up-to-date information for specification revisions.

The objective of this research will be to determine strategies and processes to broaden escalation clauses through expanded material indexing and improved estimating approaches for commodity/composite materials and labor fluctuations. This approach will help state DOTs equitably share risk with the contractors, reduce overall project cost, and fairly compensate contractors during periods of uncertainty.

Direction from the AASHTO Committee on Research & Innovation: Panel to discuss the required duration of the project.

Many entities struggle to (1) keep pace with existing demands placed on maintenance activities; (2) communicate the relationship of maintenance activities and extending the service life of specific assets; (3) understand the cost of additions to the transportation system; and (4) communicate the additional funding needed to maintain those transportation systems in a succinct manner to budget decision-makers.

Few agencies are adequately funded for the maintenance activities needed to keep assets at lowest life cycle cost. Although pavements and bridges have asset management requirements, many other assets are in need of maintenance and preservation that is not adequately funded. Deferring the appropriate preventative
maintenance activities not only shortens the useful life of the asset and increases the life cycle cost, but also could lead to premature failure and potential safety and liability concerns.

Having templates and tools that are universally accepted in the industry to communicate these benefits and needs to budget decision-makers (especially elected officials) will be a benefit to not only the maintenance programs and preservation programs, but by extending the service life of each asset class.

The objectives of this research are:

1. Acknowledge and help define the relationship between maintenance activities and delaying the need for preservation work.
2. Develop templates and examples to depict the cost of annual maintenance per asset element so agencies can demonstrate the increased cost to maintain the transportation system.
3. Develop a communication tool to be used for demonstrating the additional resources needed to maintain an asset in a state of good repair and maintain the lowest life cycle cost for each asset class.

Project 19-26
Impact of Fuel Economy Standards and Vehicle Ownership Trends on Federal Gas Tax Receipts

Research Field: Administration
Source: AASHTO Committee on Funding and Finance
Allocation: $450,000
NCHRP Staff: Patrick Zelinski

State departments of transportation (DOTs) are facing funding challenges because fuel taxes are not tracking with actual road usage due to improvements in vehicle fuel efficiency. While many states have state-level fees that are annually adjusted based on changes to average vehicle fuel economy, no such adjustment exists at the federal level. The federal Highway Trust Fund relies on a flat per-gallon gasoline tax and federal fuel tax revenues, which make up 90 percent of receipts into the Highway Trust Fund, remain stagnant.

This research will build upon the existing projections published by the Congressional Budget Office that examine the solvency of the Highway Trust Fund, as well as state-specific research that examines the impact of electric and hybrid vehicles to develop a methodology for determining fees for these vehicles.

The objective of this research is to examine the impact of federal fuel economy standards and vehicle ownership trends on federal gas tax receipts to aid state DOTs in federal revenue forecasting through 2040.

Research tasks and activities could include the following:
1. A revenue forecasting methodology that incorporates changes in fuel efficiency and vehicle ownership trends for use by state DOTs to estimate federal revenues,
2. A detailed examination of projected federal revenues versus outlays post-Infrastructure Investment and Jobs Act (IIJA),
3. An examination of how electric vehicles and other alternative fuel vehicles will affect federal gas tax revenues, and
4. A review of how changes in vehicle miles traveled, alternative vehicle ownership modes, and climate initiatives may influence future federal gas tax revenues.
Direction from the AASHTO Committee on Research & Innovation: Change title and modify the scope to focus on state and federal. New title: “State and federal revenue forecasting to address zero-emission vehicle adoption.” Suggest a scope shift to focus on the need states have for effective revenue forecasting given rapid developments in ZEV deployment and state and federal target setting.

**Project 20-44(152)**

*Implementing A Guidebook for Urban and Suburban Roadway Cross Section Reallocation*

Research Field: Special Projects  
Allocation: $330,000  
NCHRP Staff: Patrick Zelinski

Design guidance exists for individual elements within a roadway, such as travel lanes, on-street parking, medians, and bicycle, pedestrian, and transit facilities. However, current design guidance does not reflect the complex and varied trade-offs transportation professionals consider for existing roadways in different contexts.

NCHRP 15-78: Guidebook for Urban and Suburban Roadway Cross Section Reallocation developed a guidebook and decision-making framework for roadway designers, planners, and others for identifying, comparing, evaluating, and justifying context-based cross-sectional reallocations of existing urban and suburban roadway space for multimodal safety, access, and mobility. The project has four deliverables: 1) a guidebook, 2) a decision-making spreadsheet tool, 3) a final report, and 4) a presentation providing an overview of the project.

NCHRP Project 20-44(52) seeks to directly promote implementation and technology transfer of the research products produced by NCHRP Project 15-78 by:

- creating awareness through training and outreach,
- providing hands-on practice through pilot projects,
- implementing a cross section decision-making tool, and
- developing implementation support materials.

**Project 20-130**

*Incorporation of the Human Factors Guide into Transportation Agency Practices*

Research Field: Special Projects  
Source: Arkansas Department of Transportation  
Allocation: $450,000  
NCHRP Staff: Mike Brooks

*NCHRP Report 600: Human Factors Guidelines for Road Systems* (HFG) was developed to assist transportation agencies to provide a roadway environment that appropriately suits users’ capabilities and limitations. The HFG compiles knowledge on humans’ visual, cognitive, and other abilities into guidelines to assist practitioners in making design and operation decisions about the roadway environment that meet users’ needs. A communications, marketing, and implementation plan will help increase awareness of the HFG, including the updated content developed under NCHRP Projects 17-80 and 22-46, will promote use of the existing resources to support implementation, and will help identify additional implementation needs.

The objective of this research is to develop an implementation plan, along with related tools, communications, marketing, and other related resources (such as additional primers, case studies, etc.) to support increased awareness and use of HFG to support expanded consideration of human factors in decisions concerning the
roadway system. Anticipated tasks include (1) existing human factors research; (2) development of plans to promote widespread usage of the HFG; (3) development of outreach materials for AASHTO, TRB committees, and state DOTs to achieve the same; (4) development of resources for state DOT implementation; and (5) identification of additional resources needed to support HFG implementation.

**Project 22-60**

*Development of MASH Test Procedures for Motorcycles*

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<tr>
<td>Source:</td>
<td>Michigan Department of Transportation</td>
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<td>NCHRP Staff:</td>
<td>David Jared</td>
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State transportation agencies are faced with challenges regarding motorcycle safety related to roadside safety hardware (RSH). Real world crash data shows that impacts against roadside safety systems represent a higher risk of fatality and incapacitating injury for motorcycle riders than for vehicle occupants. The design, construction, maintenance, and retrofit of roadway facilities requires an inclusive approach that considers the interactions between a vehicle and the roadway. This approach is essential so that the facility can provide the safest possible driving environment.

If barrier systems can be designed to mitigate the severity of impacts of seated and unseated motorcycle riders with traffic barriers, then these barrier systems can be adopted by transportation agencies as an effective countermeasure at appropriate locations to provide a significant reduction in motorcyclist fatalities and incapacitating injuries. Although other international crash testing standards include consideration of motorcyclists in barrier design, the AASHTO *Manual for Assessing Safety Hardware* (MASH) does not currently contain protocols for testing roadside barriers for motorcyclist impacts. Consequently, roadside safety barriers in the United States are not designed, tested, or evaluated with contemplation of impact by vulnerable motorcyclists.

Several state departments of transportation (DOTs) have taken independent action to incorporate motorcyclist safety into their barrier systems. The scope of this project is to develop a comprehensive approach and recommend test procedures for evaluating RSH under motorcycle impact conditions. This research will provide the opportunity to develop national guidelines for testing and evaluation of roadside safety systems with motorcycle safety as an emphasis. Application of nationally recognized uniform and scientifically supported methods will support the development of motorcyclist-friendly hardware solutions for implementation by transportation agencies.

**Project 22-61**

*Evaluation of Electrical Vehicle Compatibility with MASH Roadside Hardware*

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<td>Ann Hartell</td>
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Electrical vehicles (EVs) are increasing in popularity and legislation was adopted by California to ban gasoline-powered passenger vehicles by 2035; similar measures are being considered in other states. EVs tend to be heavier than gasoline vehicles by between 20 and 50 percent for models with similar cabin sizes and power outputs. Also, EVs have significantly different structures than gasoline vehicles: instead of an internal combustion engine, EVs utilize battery packs commonly mounted in the floorpan, and electrical motors that affect vehicle crush space, center-of-gravity height, and structural frame of the vehicle. The differences between EVs and gasoline vehicles could lead to incompatibilities with existing roadside hardware, especially devices
AASHTO MASH defines the crashworthiness evaluation criteria and test conditions necessary to evaluate roadside safety hardware. MASH requires that test vehicles meet certain inertial and dimensional criteria and that vehicles be reasonably representative of commonly available, high-sales volume vehicles. Results of this research will help guide future editions of MASH, the Roadside Design Guide, and other AASHTO documents.

The objective of this research is to explore the compatibility between EV and current roadside hardware, and to determine what is necessary to produce an implementation framework for roadside hardware if EVs are added to the AASHTO MASH evaluation matrix.

- Select candidate vehicles for testing (review sales data, review inertial data, structural data for vehicles).
- Select systems for testing.
- Explore level of effort, resource needs, implementation challenges, and other potential impacts of redeveloping (or adapting) hardware for this new class of vehicles.
- Determine hardware design considerations (such as compatibility with other devices, working width and zone of intrusion, design strengths, load heights and barrier geometries).
- Determine implementation framework for roadside hardware if EVs are added to MASH evaluation matrix.
- Conduct selected crash tests to evaluate the framework.

**Project 22-62**  
*Reduced Impact Angles with Temporary Barriers in Work Zones*

Research Field: Design  
Source: Michigan Department of Transportation  
Allocation: $400,000  
NCHRP Staff: Ann Hartell

Positive protection (i.e., temporary construction barriers) are used in work zones to separate construction workers from adjacent traffic. When temporary barriers are impacted by an errant vehicle, they will deflect a few inches up to several feet into the work area. At the same time, providing a non-work area behind temporary barrier further constricts the already limited work area. Devices placed in work zones, such as temporary barriers, must be full-scale crash tested to the same criteria—typically 25-degree impact angles and 62 mph impact speeds—as other roadside devices based on the AASHTO Manual for Assessing Safety Hardware (MASH) or similar test criteria. However, lanes are often narrower in work zones, reducing the potential encroachment angle. Additionally, work zones are by nature temporary, so the exposure and overall potential for an errant vehicle to impact a work zone device is much less than permanent roadside devices. Several agencies, including Caltrans, Virginia Department of Transportation (DOT), North Carolina DOT, and Pennsylvania DOT, make allowances for assuming reduced impact angles at different levels of application. A more scientific approach is needed to understand benefits, costs, and potential crash scenarios.

The research objective is to develop temporary barrier warrants, placement guidelines, and associated barrier deflection characteristics to optimize work zone designs, specifically using reduced impact angles, for road user and worker safety. These guidelines may include designing temporary barrier in work zones where shallower
angle vehicle impacts or lower impact speeds may occur and criteria for consideration such as number of lanes, lane widths, speed, traffic volume, and work zone layout. The research should evaluate temporary concrete barriers with flexible connections, pin and loop types of connection, and moment bearing connections, like an “X-Bolt” type of connection. Additionally, varying barrier lengths should be evaluated to determine the contribution of length to barrier deflection. The results of NCHRP Project 03-134, “Determination of Encroachment Conditions in Work Zones” should be reviewed and incorporated as necessary.

Computer programs will be used to perform this research. Results of earlier full-scale crash tests can be used to validate simulations performed for this proposed research. This will allow for use of parametric studies of varying impact conditions for the simulations to establish criteria for implementation.

**Project 22-63**

*Updating Finite Element Analysis (FEA) Verification and Validation (V&V) Procedures and Reporting*

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<td>NCHRP Staff:</td>
<td>Ahmad Abu-Hawash</td>
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Crash simulations using finite element analysis (FEA) are used to design and help evaluate the safety performance of roadside safety hardware and features. Roadside safety crash simulations involve developing finite element models of vehicles and roadside appurtenances and using these models to simulate the vehicles impacts with the appurtenances.

The criteria for assessing accuracy between simulation results and physical crash test data were based on the repeatability of 10 full-scale crash tests performed by five different testing agencies involving oblique impacts of a small car into a rigid vertical-faced barrier. These thresholds may not be applicable to other impact events involving greater barrier deformations, different barrier types (e.g., steel post and post), shorter duration events (e.g., impact with a sign support), or component tests. While these procedures have unified simulation comparisons for the past several years, there is a need to update the verification and validation (V&V) procedures to current testing standards, for a larger array of impacts, and to update and improve the Roadside Safety Simulation Validation Program (RSSVP) software. Additionally, the simulation reporting format should be standardized beyond the V&V process to allow transportation agencies to review simulation results more easily.

The objective of this research is to update the V&V procedures for roadside safety hardware FEA and to standardize the reporting format. Some of the possible updates include using AASHTO Manual for Assessing Safety Hardware (MASH) evaluation criteria instead of NCHRP Report 350 evaluation criteria; evaluating comparison thresholds for other impacts beyond oblique, rigid barrier full-scale impacts; adding criteria for validation against multiple crash tests on the same system; considering a level of validation of various components of the system; including a discussion on basic model limitations; including criteria for comparing occupant compartment deformation; standardizing the critical information and format for simulation results to be presented in a report-like format; and updating or replacing RSSVP curve comparison software to be more compatible with current computer platforms, and make it easier to compare multiple simulations.

The research should recommend future research needs including a roadmap for FHWA and state departments of transportation to certify simulation results as an alternative to full-scale crash testing when possible. One current challenge for practitioners reviewing simulation results is identifying the extent of changes when a roadside safety hardware system has been modified (i.e., slightly, moderately, or heavily modified). The research may also recommend how to document or certify simulation analysts’ skills.

**Project 23-34**
Transportation and its infrastructure are not ends in themselves, but means for accessing places for economic activity, i.e., overcoming the friction between where you are and where you want to be. Transportation agencies, state departments of transportation (DOTs), and other infrastructure owner-operators (IOOs) work to create public value in providing safe mobility. This is balanced with a desire to support societal goals and improve the quality of life. Many agencies continue evolving toward community-centered transportation by adopting more comprehensive and outcome-oriented goals for accessibility, affordability, resiliency, sustainability, public health, and security.

Measuring these less conventional outcomes (i.e., compared to traffic delay or pavement condition) remains an immature practice and not widely done. There is a legacy of a strong, institutionalized bias toward infrastructure- and auto-oriented performance. Yet many emerging measures are closely tied to diverse societal goals, and practice is advancing in pockets around the country, including efforts to influence investment decision-making through a more comprehensive performance framework.

The objective of this research is to achieve a more coherent national practice by documenting the current state of the art, identifying methodological and institutional gaps, and charting a path toward elevating practice nationwide. Lessons will be identified from the evolution of traditional measures like pavement condition or level of service, each decade in the making and continuing to evolve, be reimagined, or even discarded. Once-novel travel time reliability is also now a “traditional” measure, but not before the Second Strategic Highway Research Program (SHRP2) began 15 years ago. This research will evolve contemporary measures, help expand emerging leading practices for adoption by agencies around the nation, and advance improved measurement, integration, and incorporation of important policy goals into investment decision-making.

Direction from the AASHTO Committee on Research & Innovation: Better define the scope of work (no direct action).

Research Program (SHRP2) began 15 years ago. This research will evolve contemporary measures, help expand emerging leading practices for adoption by agencies around the nation, and advance improved measurement, integration, and incorporation of important policy goals into investment decision-making.

**Project 23-35**

*Developing New Performance Metrics for Risk Management*

“Risk” can simply be defined as an uncertainty that presents either an opportunity or a threat regarding an agency’s ability to carry out its mission. Thus, agency success in risk management rests on the ability to quantify the impacts of the full range of uncertainties that may apply to it. Typically, these impacts are assessed in terms of the agency’s existing performance measures, like asset condition or safety. However, there may be much more to the story in terms of the potential for value creation or cost-cutting related to uncertainty. This would mean not only identifying and quantifying all sources of value/cost related to uncertainty, but would also mean considering risk management as integral to asset management, and not just an afterthought or add-on to traditional condition-based asset management.
An agency would need to quantify the benefits and costs of risk management efforts overall. For example, “We have met X% of our risk mitigation goals in the fiscal year.” Hence, depending upon the nature of the goals and objectives of an agency’s risk management program, it is essential for the agency to have a “framework” that satisfies its management needs with appropriate measures, tools, methods, and processes. “Metrics” is a useful term not only for defining appropriate “measures” for quantifying risk-related entities, but also in articulating how these measures will be utilized in the overall risk management framework.

There are good examples of transportation agency capabilities in risk management including risk management plans documented in their 2019 TAMP submissions. But there is still significant room to increase these capabilities, especially given the diversity of agencies, the types of risks and uncertainties they face, and the breadth and depths of the frameworks, methods, tools, and valid processes needed to meet increasing requirements for consistency and success in risk reduction across agencies. The term “new metrics” has been coined for a reason, to elevate risk management to a new level, where a comprehensive examination of cost cutting, and value creation options is conducted in managing the range of uncertainties that agencies face.

The purpose of this research is to:
1. Document practitioners’ current practices, ideas, and preferences for managing risks and assessing the value-add of risk management programs.
2. Gather best practices for managing risks, valuing risk management overall, and implementing process improvement across the public and private sectors, including the use of “metrics.”
3. Create the basis for a “roadmap” that defines a coherent evolution in the use of performance metrics for risk management that is sensitive to the differences in agency situations, maturities in risk management, and diversity of threats.
4. Develop practical, actionable guidance for developing and using risk management metrics in transportation agencies.

Project 23-36

*Development of a Knowledge Capture Toolkit for State DOTs*

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Knowledge management (KM) has been instituted in many types of organizations including the private sector, federal agencies, and military. KM is also being adopted by state departments of transportation (DOTs) since there is a critical need to advance the practice of KM, particularly in capturing valuable transportation knowledge. State DOTs are experiencing high retirement rates along with the need to rapidly onboard new transportation researchers and practitioners. With turnover and loss of expertise, DOTs need a way to capture critical knowledge before employees leave. Hence it is essential that state DOTs understand the full range of methods available for knowledge capture. A framework of knowledge capture practices is needed from which any agency can draw to design a solution that suits its environment. This KM capture toolbox must be suited to the transportation sector.

The goal of this research is to develop a framework of practical methods for capturing critical transportation knowledge. The toolkit should provide guidance on how to (1) identify critical transportation knowledge; (2) identify the sources of critical transportation knowledge; (3) determine who needs to know it; and (4) choose a capture method that aligns with agency goals and culture. The toolkit will provide guidelines on how to select, adapt, and apply those methods at the agency level, along with useful templates and other resources DOTs can use with minimal adaptation.
Training agency personnel in knowledge capture skills will enhance the value of agency onboarding efforts. KM champions need tangible tools for knowledge capture and to show executives and other areas specific ways it could be done. Since there are few dedicated KM degree programs at state universities and KM consultants, this toolkit may fill some of that void. It could also help agencies teach knowledge capture to staff of all disciplines.

**Project 23-37**

*Guide for Effectively Linking Performance Measures, Risk Management, and Process Improvement*

Research Field: Administration  
Source: AASHTO Committee on Performance Management  
Allocation: $400,000  
NCHRP Staff: Jennifer L. Weeks

Multiple research efforts have looked independently at the disciplines of performance measures, risk management, and process improvement. However, little research has taken place regarding the relationship between the three efforts and the benefits and challenges of linking them. Generally, these strategic disciplines and planning processes are established and managed separately within the specific system, which may impact efficiency, create redundancies, and disrupt the execution of these efforts due to conflicting and mixed responses. Research is needed to understand strategic opportunities to align the processes and identify an agency framework that links these processes to provide policy continuity and organizational efficiencies across the agency.

The objective of this research is to develop a framework to strategically align performance management, risk management, and process improvements within an agency to achieve a common set of organizational goals and objectives. The research should at a minimum seek to achieve the following:

1. Gather information on best practices for each discipline.  
2. Clearly outline successes and best practices in each field.  
3. Define any obstacles and opportunities to link the disciplines that may exist.  
4. Highlight common/uncommon language between the disciplines that may cause confusion.  
5. Develop a framework on how to best link the disciplines.  
6. Determine the best communication tools to support the framework.

State departments of transportation (DOTs) could see substantial operational and policy efficiencies and reduction in workflow and communications conflicts and redundancies through the establishment of a global framework that links agency performance measures, risk management, and process improvements or modifications.

**Project 23-38**

*Incorporating Risk Management into Maintenance Practice*

Research Field: Materials and Construction  
Source: AASHTO Committee on Performance-Based Management  
Allocation: $500,000  
NCHRP Staff: Ann Hartell

To fulfill the requirements of the Moving Ahead for Progress in the 21st Century Act (MAP-21) and the Fixing America's Surface Transportation Act (FAST Act), state departments of transportation (DOTs) started to establish enterprise risk management (ERM) programs and develop risk-based asset management plans. FHWA Directive 5520 further encourages state DOTs to develop risk-based, cost-effective strategies to minimize the impacts of climate change and extreme weather events. Environmental stressors, such as natural disasters (e.g.,
earthquake, floods, high wind, and wildfire) and higher average temperatures are changing the life cycle of transportation assets, changing the maintenance needs of infrastructure assets. Incorporating climate change into risk modeling and risk-based maintenance planning is important for an informative, forward-looking, and sustainable decision making and funding allocation strategy. Maintenance personnel offer valuable insight to costs associated with achieving performance goals. At the same time, maintenance personnel need guidance on how to incorporate risk models into maintenance, inspection, replacement, and repair cycles so that scheduled and routine maintenance continue to mitigate the risk from asset deterioration.

The purpose of the proposed project is to develop a guide and prototype tool to help state DOTs assess and manage risk in maintenance practice. The project is anticipated to include a review of methodologies and tools used for risk assessment and management and how they are integrated into asset management and maintenance practice (at enterprise level, program level, and project level). Pilot activities and a prototype version of the guide and tool are also anticipated.

**Project 23-39**

*Strategies for Construction Inspector Career Paths in State Departments of Transportation Agencies for Retaining and Advancing Capabilities*

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<td>Jennifer L. Weeks</td>
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State departments of transportation (DOTs) are experiencing a shortage of trained, experienced, and credentialed transportation construction inspectors (CIs). In many state DOTs, opportunities for advancement as a CI are limited, and individuals look at inspection positions as a job and not a career. Without clearly defined career paths, where professional development can lead to advancements, CIs are more likely to leave or may not be attracted to the transportation construction industry where other disciplines tend to have established career paths. Lastly, DOTs compete for competent CIs with other industries (vertical construction, for example) and the private sector where career paths may be better defined. Research is needed to develop strategies for developing career paths for CIs, or other programs or methods to attract and retain trained, experienced, and credentialed CIs in transportation.

The objective of this research is to develop a guide to attract, develop, and retain a career path model or framework for CIs. This will be accomplished by researching the current transportation CI career paths at DOTs, consultants providing CI services, and other professional disciplines to inform the development of a career path model for the CI at DOTs. The supporting information will include best practices and recommended strategies and opportunities that could result in the increased retention of CIs.

The construction industry in the United States continues to experience significant workforce shortages. This workforce shortage is particularly challenging for DOTs where CIs must have years of experience and maintain specific credentials to ensure that federal, state, and local transportation funds result in long-lasting public transportation facilities. For the last two decades there has been a natural attrition of CI staff due to retirements in the post-Interstate era and continued downsizing of the DOT workforce. Once a CI is recruited, trained, and credentialed, there is a need to provide clearly defined career paths to retain the talent. A CI with the knowledge, skills, and experience overseeing work will result in better constructed transportation projects and achieve greater value for the DOT.

**Project 23-40**

As highway maintenance equipment fleet technology continues to rapidly advance, the tools used to define maintenance technician staffing levels must also advance. Typically, the number of maintenance technicians assigned to an agency location is based on financial constraints, fleet age, fleet equipment class mix, annual usage measurements, powertrain types and complexities, the amount and type of work outsourced, and a multitude of other key factors. In the past, a simple measurement was used to determine whether a highway maintenance equipment fleet had adequate maintenance technician staff—a basic equipment type-to-mechanic ratio was established. However, department of transportation (DOT) fleets are aging and creating additional demands for repair at a time when DOTs are having difficulty hiring qualified equipment technicians. Repair costs are increasing, and budgets are unable to keep up.

Research is needed to assist states determine proper resources needed to maintain their equipment fleets efficiently. The research should address the following: equipment return time, equipment availability, repair returns, equipment down time related to technician availability, capabilities, and cost efficiencies when determining which in-house or commercial outsourced repairs are appropriate for that fleet.

The objective of this research is to develop and provide a methodology and a tool to guide DOT fleet managers and shop managers to determine proper technician resources required to maintain their fleets efficiently. Separate methodologies should be developed for (1) maintenance and repair and (2) preventive maintenance.

It is critical to identify the proper technician resources to ensure proper fleet maintenance, perform timely preventive maintenance, and guarantee equipment is available when needed. The requested research would enable fleet and shop managers to determine what resources are needed to adequately staff equipment repair facilities to ensure equipment is available for use when needed and to make efficient repair decisions regarding in-house or outsourced repairs.

Project 23-41

Using Emerging Technologies to Capture, Process, and Optimize Asset Inventory and Condition Data

Agencies are becoming more reliant on asset inventory and condition data to create a virtual digital twin to the real-world assets that exist and change over time. Changes can result from crashes, natural events, maintenance, or construction activities. These changes need to be reflected in the digital twin as close to real time as possible to maintain the usefulness and validity of the virtual twin.

Emerging and current technologies hold the promise of transforming asset data collection for transportation asset management such as the use of drones for inspections, LiDAR field data collection, and continuous monitoring of real-time sensor data. While the technology has been transforming, Moving Ahead for Progress in the 21st Century Act (MAP-21) and the Fixing America's Surface Transportation Act (Fast Act) jump started many agencies’ efforts to attain an inventory of infrastructure assets and transportation data. At the same time, the accessibility and affordability to collect high volumes of asset inventory data—such as LiDAR point cloud data—present a challenge to agencies seeking to visualize and manage such large amounts of data and integrate the many layers for each transportation asset management plan. Now that the need for such data is federally
recognized, further research is needed to understand what the latest technologies for asset management can offer an agency as well as how frequently that information needs to be captured and optimized.

State and local transportation agencies are rapidly adopting asset management practices to optimize infrastructure conditions for the resources available and to meet federal transportation asset management planning requirements. There is a profound need to invest in technology and systems to understand the fully inventoried condition of various transportation assets and to model the outcomes of various investment strategies. The purpose of this research is to examine emerging and established technologies used to capture and update changes to assets in the field and the necessary steps to ensure that these changes are processed and integrated into the authoritative systems as close to real time as possible. This examination will help determine the utility of the data, and how to collect, manage, and apply it more effectively.

**Project 24-52**  
**Design Guidance for Resilient Erosion and Sediment Control Technologies**

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Construction operations are regulated through the Clean Water Act, requiring construction operators to file for a construction general permit (CGP), develop a stormwater pollution prevention plan (SWPPP), and implement erosion and sediment control (E&SC) practices during land-disturbing activities to minimize the transport and discharge of sediment that may impact downstream waterbodies. E&SC is a considerable cost, estimated to be as high as 8% of the total budget for highway construction projects. Several state departments of transportation (DOTs) have recently faced penalties, fines, and legal actions due to inadequate design and implementation of SWPPPs. This is in part due to insufficient engineering-based design guidance for proper selection, sizing, placement, and maintenance of resilient E&SC practices.

Construction activities are prone to higher rates of erosion during periods of land disturbances where poor vegetative cover is in place to protect exposed soil. Forces that affect erosion on construction sites may be from rainfall (splash erosion), runoff (exceeding allowable shear forces), and from wind (saltation and creep). To appropriately determine the selection, sizing, and placement of resilient E&SC practices, designers should consider expected runoff rate, volume, and sediment loads based on site-specific design storm characteristics and hydrologic soil conditions. However, existing technical resources required for the successful development of SWPPPs lack engineering-based design guidance. The development of a project-specific SWPPP is often described as an “art”, with engineers relying on “rules of thumb” for the design and selection of E&SC practices. Claims of E&SC product performance may be based on manufacturer’s assertions or simple field observations where installed practices or products are monitored over time and during naturally occurring rain events. Without an adequate risk-based assessment, temporary E&SC practices sometimes fail because stormwater volumes and flow rates are higher than the installed practice or product was originally intended to treat. Significant effort, time, and cost is invested in repairing failed E&SC practices and remediating impacted waterways. Conversely, many E&SC practices are overdesigned for the actual encountered runoff or specified for placement in locations and in a manner that creates inefficiencies and unnecessary additional cost.

This project seeks to develop risk- and resilience-based hydrologic standards to use in the design of resilient E&SC practices for highway construction. The project will identify and evaluate appropriate risk-based hydrologic approaches, as well as develop guideline on the resiliency, selection, sizing, placement, and maintenance of non-proprietary practices commonly specified in SWPPPs. Researchers will examine the applicability of risk-based design approaches and determine potential effectiveness and drawbacks for implementation in SWPPPs.
Interseeding (also known as overseeding) can increase flowering plant diversity in grass-dominated stands of vegetation but has rarely been used on roadsides. Interseeding techniques have been mostly utilized in agricultural lands as an innovative cover crop program that helps protect the soil and protect against climate change or to increase plant diversity in remnant vegetation that has degraded over time and from which management has not been able to recover species diversity. State departments of transportation (DOTs) may benefit from this seeding technique to increase native plant diversity and provide natural control of non-native/invasive grass species.

The objective of this project is to provide information on interseeding and other strategies to increase native wildflower diversity within existing roadside vegetation in a cost-effective manner. Potential tasks include (1) a survey of DOTs for concerns and current practices; (2) a review of available literature and other resources on approaches and constraints to site preparation, seeding methods, seed mixes and rates, and ongoing weed control in sites with existing vegetation; (3) a summary of differences in regional approaches and areas where additional information is needed; (4) production of a guide with a summary of suggested practices for different regions of the United States; and (5) development of a framework field protocol for testing site preparation and seeding methods and evaluating results in terms of success, labor needs, budget, and scheduling.

Greenhouse gases (GHGs) are those that absorb and emit infrared radiation in the wavelength range emitted by the Earth. They contribute to warming through the greenhouse effect. Given transportation’s role in producing GHGs, many state departments of transportation (DOTs) have undertaken efforts toward decarbonization or reducing GHGs emissions. Moving forward, it will be important for transportation agencies to understand which strategies and projects lower GHGs, and to what extent.

The objective of this project is to develop an effective, implementable framework to evaluate decarbonization efforts for transportation agencies. The framework will assist transportation agencies with strategic planning for carbon reduction measure development and evaluation. The framework will include (1) consideration of carbon reduction in long-range plan development; (2) consideration of emissions effects in project evaluation and prioritization for programming; and (3) consideration of emissions effects and mitigation strategies in
corridor/subarea planning, project development, and delivery. A key element to the success of the project will be engaging partners in user acceptance testing to support future implementation.

Direction from the AASHTO Committee on Research & Innovation: National decarbonization strategy/blue print (Energy Department and EPA - tie work to these efforts and coordinate).

Project 25-71

Roadside Vegetation Management Guidelines for Prevention and Management of Wildfire

Research Field: Transportation Planning
Source: Washington State Department of Transportation
Allocation: $300,000
NCHRP Staff: Mike Brooks

Wildfires have increased due to drought and invasive species, adversely impacting forest health. This is compounded by increased traffic volumes and has resulted in a range of responses in adaptive vegetation management from state departments of transportation (DOTs). States where wildfires have increased in frequency and intensity have adopted innovative solutions in emergency response and mobilization. Lessons learned can be passed along to other states as drought and invasive species challenges have increased wildfire risks across the country. A baseline study of known risk factors and current best management practices being adopted by state DOTs is needed to establish an ongoing national adaptive roadside management strategy. This baseline would be enhanced with continued documentation of incident response to each successive fire event.

The objectives of this research are to (1) identify the range and magnitude of historic case study responses to wildfire on state highway roadsides throughout the country; (2) recommend best practices for state DOTs for cases where the fire source is traffic-related, and where the highway roadside is managed to serve as a fire break and aid in emergency response; (3) develop management recommendations for state DOTs in the life cycle of roadside vegetation management; and (4) prepare suggested language for consideration by the AASHTO Committee on Environment and Sustainability for future revisions of the AASHTO Guidelines Roadside Vegetation Management on Integrated Vegetation Management response using chemical control, mechanical control, and site restoration for cultural control.

Direction from the AASHTO Committee on Research & Innovation: Eliminate the Benefit-Cost Analysis.